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Original Article

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Disability Weights Measurement for 289 Causes of Disease Considering Disease Severity in Korea

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ABSTRACT

Background: For the Korean Burden of Disease (KBD) 2015 study, we have amended disability weights for causes of disease adapting the methodology of the KBD disability weight 2012 study.
Methods: We conducted a self-administered web-based survey in Korea using ranking five causes of disease. A total of 605 physicians and medical college students who were attending in third or fourth grade of a regular course performed the survey. We converted the ranked data into paired comparison data and ran a probit regression. The predicted probabilities for each cause of disease were calculated from the coefficient estimates of the probit regression. 'Being dead (1)' and 'Full health (0)' were utilized as anchor points to rescale the predicted probability on a scale from 0 to 1.
Results: As a result, disability weights for a total of 289 causes of disease were estimated. In particular, we calculated the disability weights of 60 causes of disease considering severity level. These results show that prejudice about the severity of cause of disease itself can affect the estimation of disability weight, when estimating the disability weight for causes of disease without consideration of severity. Furthermore, we have shown that disability weights can be estimated based on a ranking method which can maximize efficiency of data collection.
Conclusion: Disability weights from this study can be used to estimate disability adjusted life year and healthy life expectancy. Furthermore, we expected that the use of the ranking method will increase gradually in disability weight studies.

Keywords: Disability Weight; Burden of Disease; Republic of Korea; Ranking Method

INTRODUCTION

Summary measures of population health (SMPH) are a combination of a fatal health condition that can lead to death and a health condition of a non-fatal health condition.[1] SMPH, also referred to as a composite indicator, is distinguished by indicators of health gap or life year and indicators of life expectancy.[2,3] The indictors of health gap are again divided into the disability adjusted life year (DALY) which is utilized in the global burden of disease (GBD) study[4] and the quality adjusted life year (QALY) which is mainly used as the

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Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Ock M, Park B, Park H, Oh IH, Yoon SJ, Cho B, Jo MW. Data curation: Ock M, Park B, Park H, Oh IH, Yoon SJ, Cho B, Jo MW. Formal analysis: Ock M, Jo MW. Methodology: Ock M, Jo MW. Validation: Ock M, Park B, Park H, Oh IH, Cho B, Jo MW. Writing - original draft: Ock M, Park B, Park H, Oh IH, Yoon SJ, Cho B, Jo MW. Writing - review & editing: Ock M.

outcome index of the cost-utility analysis.[5] Furthermore, indicators of life expectancy are also classified into the healthy life expectancy (HALE) which is utilized in the GBD study[4] and the quality adjusted life expectancy (QALE) using health-related quality of life.[6]

Among the SMPH, DALY and HALE are used to estimate the GBD, but there have been also many studies on DALY and HALE in Korea.[7-10] In order to calculate DALY and HALE, disability weight is an essential factor. The disability weight is a measure of the level of disability of particular health state and diseases, and its value lies between 0 (full health, no disability) and 1 (disability level in a state such as death).[11] That is, the disability weight plays a bridging role between mortality and morbidity when estimating DALY and HALE. Therefore, it is necessary to be able to estimate the disability weight appropriately and reliably.[12] If the disability weight of a specific disease is overestimated, the burden of the disease may be overestimated. Conversely, if the disability weight is underestimated, there is a possibility of underestimating the burden of disease.

Since 1996, many studies have been conducted to estimate disability weights in many countries.[11,13-15] Most recently, disability weights for the GBD 2013 study was performed using paired comparison as a main valuation method and disability weights for 235 health states were estimated adding the results of European disability weight study.[13,14] In the case of Korea, two disability weights studies for the Korean Burden of Disease (KBD) 2012 were conducted most recently.[11,15] In the first study, a total of 496 physician and medical students participated in self-administered web-based surveys and a total of 228 disability weights of disease causes for calculating the incidence-based DALY were estimated.[11] In the second study, a total of 2,728 and 3,188 general public participated in the household and web-based survey, respectively, and a total of 258 disability weights of health states for calculating the prevalence-based DALY were estimated.[15]

However, disability weights calculated in the past may not be valid at this time because of the emergence of new diseases or health states, changes in disease characteristics, development of treatment methods, and changes in social perspectives on disability.[12] Therefore, it is necessary to continually evaluate the validity of disability weights and to revise disability weights. In particular, there is an increasing need to calculate the more valid burden of diseases reflecting the severity level of diseases and attempts are being made to calculate the disability weight reflecting the severity level of health states.[9,15] However, there was no attempt to calculate the disability weights for disease causes reflecting the severity level of diseases.

For the KBD 2015 study, we have amended disability weights for causes of disease adapting the methodology of the KBD disability weight 2012 study. In particular, we attempted to further refine the severity level of diseases, such as cancer and diabetes, and to determine their disability weights.

METHODS

Study design and participants

We conducted a self-administered web-based survey in Korea, adapting the methodology of a preceding disability weights measurement study.[11] The survey was conducted from November 2016 to March 2017. In this study, we recruited study participants who could be expected to have enough knowledge about causes of disease. Specifically, physicians and medical students who

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were attending in the third or fourth grade of a regular course participated in the survey. We recruited participants through promotion of the survey in the lectures of medical colleges and an announcement at medical conferences, seminars and meetings.

Valuation method and causes of disease

Each participant responded to his or her age, gender, specialty, and position at the beginning of the survey. Next, the participant evaluated the causes of diseases using a ranking method. That is, the participants ranked causes of disease in order of good health in the ranking method, considering mental and physical problems. Because the survey was conducted for the medical professionals, the descriptions of causes of disease were not developed and the response was obtained by presenting the causes of disease itself to the survey participants. We used a method ranking five causes of disease, which proved to be effective in previous study.[16]

The five causes of disease were randomly selected among the 289 causes of disease. Among the 289 causes of disease, 211 causes of disease were taken from the previous disability weights measurement study without subdividing severity level.[11] For 60 causes of disease, the degree of severity was further subdivided. For example, gastric cancer was classified into four stages: gastric cancer stage I, gastric cancer stage II, gastric cancer stage III, gastric cancer IV. Osteoarthritis was subdivided into three stages: osteoarthritis (mild), osteoarthritis (moderate), osteoarthritis (severe). Diabetes mellitus was classified into two stages: diabetes mellitus without complications and diabetes mellitus with complications. Furthermore, 16 causes of disease were included in the list for the verification of the disability weight model of multimorbidity. For example, two or more causes of disease, such as patients with diabetes mellitus and osteoarthritis, were included in the list. The remaining two causes of disease were 'full health' and 'being dead.' These were included for use as an anchor points in the analysis.

Each participant performed a total of 20 ranking methods. In order to obtain a sufficient number of comparisons between 'full health' or 'being dead' and other causes of disease, 'full health' should be included in question 1 and 11, whereas 'being dead' should be included in question 5, 10, 15, and 20.

Analysis

Initially, we conducted descriptive analyses for determining the characteristics of socio-demographic factors of the participants. Before the disability weight analyses, illogical response that 'full health' was not listed as the healthiest condition were excluded from the results. Then, we converted the ranked data into paired comparison data.[16] For example, if the orders of causes of disease were "C1 > C2 > C3 > C4 > C5," they were converted as follows: "C1 > C2," "C1 > C3," "C1 > C4," "C1 > C5," "C2 > C3," "C2 > C4," "C2 > C5," "C3 > C4," "C3 > C5," and "C4 > C5." After conversion, we ran a probit regression according to the analytic methodology of previous studies.[11,15] The stated preference between the two causes of disease in the paired comparison data were regarded as the dependent variable. The 289 causes of disease were treated as independent variables and created as dummy variables with 'being dead' as the reference. The predicted probabilities for each cause of disease were calculated from the coefficient estimates of the probit regression. 'Being dead (1)' and 'Full health (0)' were utilized as anchor points to rescale the predicted probability of each cause of disease on a scale from 0 to 1. Using the 95% confidence interval (CI) of the predicted probabilities, the 95% CIs of disability weight for causes of disease were estimated.

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The calculated disability weights from this study were compared to those calculated in a preceding disability weights measurement study.[11] Stata 13.1 software (StataCorp, College Station, TX, USA) was used for all statistical analyses. *P* values less than 0.05 were regarded statistically significant in this study.

Ethics statement

This study was approved by the Institutional Review Board of the Asan Medical Center (IRB No. 2016-1271). Each participant was informed about the purpose of the survey and only those individuals who provided informed consent joined this survey.

RESULTS

A total of 605 participants performed the survey. **Table 1** shows the details of the participants' socio-demographic characteristics. The participants in the 30s were predominant and the men participants outnumbered women participants in the survey. The specialists accounted for about 60% of the total survey participants, and the medical part specialists were more than the surgical part specialists.

Of the 1,210 questions that included 'full health,' eight (0.7%) were illogical responses for which the 'full health' was not listed as the best health status. All of these illogical responses occurred in question 11. **Table 2** shows the disability weights and their 95% CIs for 289 causes of disease. The cause of disease with highest disability weight was 'trachea, bronchus and lung cancers (stage 4) (0.906),' followed by 'kidney cancer (stage 4) (0.902)' and 'brain and nervous system cancers (0.888).' The cause of disease with lowest disability weight was 'acne vulgaris (0.049),' followed by 'dental caries (0.065)' and 'allergic rhinitis (0.087).' More than half of the causes of disease (n = 166, 57.4%) had disability weight values of less than 0.5 (**Fig. 1**). Furthermore, disability weights for about 70% of causes of disease (n = 201, 69.6%) were located between 0.2 and 0.7.

Fig. 2 shows the correlation of disability weights between the disability weights for the overlapping causes of disease from this study and a previous study.[11] The Pearson correlation

Table 1. Characteristics of the study participants by type of survey

Variables	No. (%)
Age, yr	
19–29	206 (34.1)
30–39	395 (65.3)
≤ 40	4 (0.7)
Gender	
Men	450 (74.4)
Women	155 (25.6)
Specialty	
Medical part	193 (31.9)
Surgical part	78 (12.9)
Others	334 (55.2)
Position	
Medical student	164 (27.1)
General practitioner	56 (9.3)
Resident	6 (1.0)
Specialist	362 (59.8)
Others	17 (2.8)
Total	605 (100.0)

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Table 2. Disability weights for 289 causes of disease

No.	Cause of disease	Disability weight	95% CI	
			Lower	Upper
1	Tuberculosis	0.519	0.462	0.575
2	HIV disease resulting in mycobacterial infection	0.746	0.694	0.792
3	HIV disease resulting in other specified or unspecified diseases	0.787	0.740	0.828
4	Cholera	0.355	0.298	0.415
5	Other salmonella infections	0.279	0.229	0.334
6	Shigellosis	0.248	0.198	0.303
7	Enteropathogenic *E. coli* infection	0.290	0.236	0.347
8	Enterotoxigenic *E. coli* infection	0.267	0.216	0.323
9	*Campylobacter* enteritis	0.268	0.218	0.324
10	Amoebiasis	0.380	0.321	0.440
11	Cryptosporidiosis	0.518	0.459	0.577
12	Rotaviral enteritis	0.188	0.146	0.236
13	Intestinal infection	0.270	0.217	0.327
14	Typhoid and paratyphoid fevers	0.382	0.322	0.445
15	Influenza	0.149	0.112	0.194
16	Pneumococcal pneumonia	0.427	0.369	0.486
17	*H. influenzae* type B pneumonia	0.407	0.348	0.468
18	Respiratory syncytial virus pneumonia	0.367	0.309	0.428
19	Upper respiratory infections	0.131	0.096	0.173
20	Otitis media	0.176	0.134	0.224
21	Pneumococcal meningitis	0.590	0.532	0.645
22	*H. influenzae* type B meningitis	0.557	0.498	0.614
23	Meningococcal infection	0.530	0.470	0.588
24	Encephalitis	0.687	0.632	0.737
25	Diphtheria	0.340	0.284	0.398
26	Whooping cough	0.253	0.203	0.307
27	Tetanus	0.525	0.466	0.583
28	Measles	0.254	0.203	0.312
29	Varicella	0.241	0.193	0.293
30	Malaria	0.438	0.381	0.497
31	Chagas disease	0.547	0.489	0.604
32	Leishmaniasis	0.408	0.350	0.467
33	African trypanosomiasis	0.432	0.376	0.490
34	Schistosomiasis	0.381	0.323	0.442
35	Cysticercosis	0.372	0.316	0.431
36	Echinococcosis	0.412	0.354	0.471
37	Lymphatic filariasis	0.418	0.359	0.479
38	Onchocerciasis	0.319	0.264	0.378
39	Trachoma	0.437	0.376	0.498
40	Dengue	0.395	0.337	0.455
41	Yellow fever	0.504	0.444	0.563
42	Rabies	0.655	0.598	0.709
43	Ascariasis	0.231	0.183	0.284
44	Trichuriasis	0.253	0.202	0.309
45	Hookworm disease	0.241	0.193	0.295
46	Food-borne trematodiases	0.275	0.224	0.330
47	Tsutsugamushi fever	0.386	0.329	0.445
48	Typhus fever	0.390	0.332	0.449
49	Hantaan virus disease	0.472	0.411	0.532
50	Intestinal helminth	0.267	0.217	0.321
51	Maternal hemorrhage	0.514	0.453	0.575
52	Maternal sepsis	0.749	0.699	0.795
53	Hypertensive disorders of pregnancy	0.455	0.395	0.516
54	Obstructed labor	0.462	0.404	0.521
55	Abortion	0.300	0.245	0.359
56	Preterm birth complications	0.517	0.456	0.576
57	Neonatal encephalopathy (birth asphyxia and birth trauma)	0.858	0.815	0.893
58	Sepsis and other infectious disorders of the newborn baby	0.711	0.658	0.759

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Table 2. (Continued) Disability weights for 289 causes of disease

No.	Cause of disease	Disability weight	95% CI	
			Lower	Upper
59	Protein-energy malnutrition	0.414	0.356	0.474
60	Iodine deficiency	0.200	0.155	0.250
61	Vitamin A deficiency	0.153	0.115	0.197
62	Iron-deficiency anemia	0.170	0.131	0.216
63	Syphilis	0.452	0.393	0.511
64	Sexually transmitted chlamydial diseases	0.253	0.205	0.307
65	Gonococcal infection	0.307	0.255	0.364
66	Trichomoniasis	0.316	0.259	0.377
67	Herpes genitalia	0.286	0.231	0.345
68	Acute hepatitis A	0.364	0.307	0.424
69	Acute hepatitis B	0.431	0.372	0.491
70	Acute hepatitis C	0.501	0.441	0.561
71	Acute hepatitis E	0.467	0.407	0.526
72	Leprosy	0.613	0.558	0.665
73	Legionnaires' disease	0.345	0.288	0.405
74	Leptospirosis	0.415	0.355	0.475
75	Rubella	0.359	0.301	0.418
76	Mumps	0.202	0.157	0.253
77	Esophageal cancer	0.841	0.802	0.875
78	Stomach cancer (stage 1)	0.462	0.403	0.520
79	Stomach cancer (stage 2)	0.669	0.614	0.720
80	Stomach cancer (stage 3)	0.823	0.780	0.860
81	Stomach cancer (stage 4)	0.880	0.840	0.912
82	Liver cancer secondary to hepatitis B	0.796	0.749	0.837
83	Liver cancer secondary to hepatitis C	0.802	0.755	0.842
84	Liver cancer secondary to alcohol use (stage 1)	0.603	0.541	0.661
85	Liver cancer secondary to alcohol use (stage 2)	0.718	0.666	0.766
86	Liver cancer secondary to alcohol use (stage 3)	0.785	0.737	0.827
87	Liver cancer secondary to alcohol use (stage 4)	0.876	0.838	0.907
88	Larynx cancer	0.824	0.784	0.859
89	Trachea, bronchus and lung cancers (stage 1)	0.600	0.542	0.656
90	Trachea, bronchus and lung cancers (stage 2)	0.738	0.686	0.785
91	Trachea, bronchus and lung cancers (stage 3)	0.758	0.710	0.801
92	Trachea, bronchus and lung cancers (stage 4)	0.906	0.873	0.932
93	Breast cancer (stage 1)	0.439	0.379	0.500
94	Breast cancer (stage 2)	0.597	0.535	0.657
95	Breast cancer (stage 3)	0.724	0.671	0.771
96	Breast cancer (stage 4)	0.864	0.826	0.895
97	Cervical cancer (stage 1)	0.431	0.372	0.491
98	Cervical cancer (stage 2)	0.553	0.493	0.611
99	Cervical cancer (stage 3)	0.813	0.767	0.851
100	Cervical cancer (stage 4)	0.855	0.815	0.889
101	Uterine cancer	0.711	0.661	0.757
102	Prostate cancer (stage 1)	0.458	0.399	0.518
103	Prostate cancer (stage 2)	0.613	0.552	0.672
104	Prostate cancer (stage 3)	0.742	0.692	0.787
105	Prostate cancer (stage 4)	0.838	0.795	0.874
106	Colon and rectum cancers (stage 1)	0.496	0.436	0.556
107	Colon and rectum cancers (stage 2)	0.689	0.631	0.742
108	Colon and rectum cancers (stage 3)	0.841	0.798	0.878
109	Colon and rectum cancers (stage 4)	0.870	0.833	0.900
110	Mouth cancer	0.870	0.828	0.905
111	Nasopharynx cancer	0.766	0.716	0.811
112	Cancer of other part of pharynx and oropharynx	0.811	0.764	0.851
113	Gallbladder and biliary tract cancer	0.800	0.752	0.843
114	Pancreatic cancer	0.879	0.843	0.909
115	Malignant melanoma of skin	0.786	0.737	0.829
116	Non-melanoma skin cancer	0.649	0.593	0.702

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Table 2. (Continued) Disability weights for 289 causes of disease

No.	Cause of disease	Disability weight	95% CI	
			Lower	Upper
117	Ovarian cancer	0.776	0.727	0.821
118	Testicular cancer	0.692	0.637	0.744
119	Kidney cancer (stage 1)	0.570	0.509	0.627
120	Kidney cancer (stage 2)	0.731	0.678	0.778
121	Kidney cancer (stage 3)	0.809	0.762	0.849
122	Kidney cancer (stage 4)	0.902	0.870	0.927
123	Other urinary organ cancers	0.711	0.656	0.761
124	Bladder cancer (stage 1)	0.500	0.441	0.558
125	Bladder cancer (stage 2)	0.623	0.567	0.676
126	Bladder cancer (stage 3)	0.769	0.720	0.812
127	Bladder cancer (stage 4)	0.869	0.830	0.901
128	Brain and nervous system cancers	0.888	0.852	0.918
129	Thyroid cancer (stage 1)	0.301	0.248	0.359
130	Thyroid cancer (stage 2)	0.484	0.425	0.543
131	Thyroid cancer (stage 3)	0.639	0.583	0.691
132	Thyroid cancer (stage 4)	0.779	0.730	0.822
133	Hodgkin's disease	0.670	0.612	0.725
134	Non-Hodgkin lymphoma	0.689	0.636	0.737
135	Multiple myeloma	0.764	0.714	0.808
136	Leukemia	0.812	0.765	0.854
137	Bone and connective tissue cancer	0.765	0.717	0.809
138	Benign neoplasm of brain and other parts of central nervous system	0.505	0.442	0.567
139	Rheumatic heart disease	0.600	0.542	0.657
140	Ischemic heart disease	0.534	0.475	0.592
141	Ischemic stroke (mild)	0.540	0.477	0.601
142	Ischemic stroke (moderate)	0.787	0.740	0.828
143	Ischemic stroke (severe)	0.840	0.799	0.875
144	Hemorrhagic and other non-ischemic stroke	0.785	0.738	0.825
145	Hypertensive heart disease	0.502	0.444	0.560
146	Cardiomyopathy and myocarditis	0.717	0.661	0.768
147	Atrial fibrillation and flutter	0.584	0.526	0.641
148	Aortic aneurysm	0.647	0.591	0.700
149	Peripheral vascular disease	0.430	0.368	0.492
150	Endocarditis	0.646	0.589	0.700
151	Hermorrhoid	0.139	0.103	0.182
152	Varicose veins of lower extremities	0.173	0.132	0.219
153	Chronic obstructive pulmonary disease (mild)	0.408	0.351	0.466
154	Chronic obstructive pulmonary disease (moderate)	0.703	0.648	0.754
155	Chronic obstructive pulmonary disease (severe)	0.722	0.668	0.771
156	Pneumoconiosis	0.669	0.614	0.721
157	Asthma	0.396	0.337	0.458
158	Interstitial lung disease and pulmonary sarcoidosis	0.678	0.623	0.729
159	Cirrhosis of the liver secondary to hepatitis B	0.707	0.655	0.755
160	Cirrhosis of the liver secondary to hepatitis C	0.706	0.653	0.754
161	Cirrhosis of the liver secondary to alcohol use (mild)	0.484	0.424	0.543
162	Cirrhosis of the liver secondary to alcohol use (moderate)	0.668	0.612	0.722
163	Cirrhosis of the liver secondary to alcohol use (severe)	0.717	0.664	0.765
164	Peptic ulcer disease	0.260	0.207	0.319
165	Gastritis and duodenitis	0.144	0.107	0.187
166	Appendicitis	0.245	0.196	0.300
167	Paralytic ileus and intestinal obstruction without hernia	0.388	0.332	0.446
168	Inguinal or femoral hernia	0.269	0.220	0.322
169	Crohn's disease	0.597	0.538	0.653
170	Ulcerative colitis	0.545	0.485	0.604
171	Vascular disorders of intestine	0.515	0.455	0.573
172	Gallbladder and bile duct disease	0.448	0.386	0.511
173	Pancreatitis	0.498	0.436	0.559
174	Gastroesophageal reflux disease	0.163	0.123	0.209

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Table 2. (Continued) Disability weights for 289 causes of disease

No.	Cause of disease	Disability weight	95% CI	
			Lower	Upper
175	Alzheimer's disease and other dementias	0.736	0.685	0.782
176	Parkinson's disease	0.660	0.606	0.711
177	Epilepsy	0.581	0.523	0.637
178	Multiple sclerosis	0.693	0.640	0.742
179	Migraine	0.190	0.148	0.237
180	Tension-type headache	0.163	0.121	0.212
181	Schizophrenia	0.666	0.612	0.717
182	Alcohol use disorders	0.350	0.295	0.407
183	Opioid use disorders	0.457	0.398	0.517
184	Cocaine use disorders	0.459	0.401	0.518
185	Amphetamine use disorders	0.473	0.413	0.534
186	Cannabis use disorders	0.355	0.299	0.413
187	Major depressive disorder (mild)	0.279	0.229	0.333
188	Major depressive disorder (moderate)	0.528	0.469	0.586
189	Major depressive disorder (severe)	0.569	0.509	0.627
190	Dysthymia	0.188	0.145	0.238
191	Bipolar affective disorder	0.483	0.424	0.542
192	Panic disorder	0.391	0.335	0.448
193	Obsessive-compulsive disorder	0.321	0.266	0.378
194	Post-traumatic stress disorder	0.415	0.357	0.474
195	Anorexia nervosa	0.420	0.363	0.478
196	Bulimia nervosa	0.392	0.334	0.451
197	Autism	0.510	0.449	0.570
198	Asperger's syndrome	0.408	0.349	0.469
199	Attention-deficit hyperactivity disorder	0.249	0.200	0.302
200	Conduct disorder	0.275	0.224	0.331
201	Idiopathic intellectual disability	0.483	0.422	0.543
202	Borderline personality disorder	0.397	0.340	0.455
203	Diabetes mellitus without complications	0.334	0.279	0.391
204	Diabetes mellitus with complications	0.663	0.605	0.717
205	Acute glomerulonephritis	0.420	0.362	0.480
206	Chronic kidney disease due to diabetes mellitus	0.674	0.617	0.727
207	Chronic kidney disease due to hypertension	0.594	0.534	0.652
208	Tubulointerstitial nephritis, pyelonephritis, and urinary tract infections	0.359	0.302	0.418
209	Urolithiasis	0.294	0.242	0.350
210	Benign prostatic hyperplasia	0.207	0.161	0.259
211	Men infertility	0.332	0.279	0.389
212	Urinary incontinence	0.287	0.233	0.345
213	Uterine fibroids	0.223	0.177	0.274
214	Polycystic ovarian syndrome	0.399	0.342	0.458
215	Women infertility	0.362	0.306	0.421
216	Endometriosis	0.349	0.292	0.408
217	Genital prolapse	0.404	0.338	0.471
218	Premenstrual syndrome	0.136	0.101	0.179
219	Thalassemias	0.485	0.425	0.545
220	Sickle cell disorders	0.552	0.494	0.609
221	G6PD deficiency	0.519	0.458	0.580
222	Rheumatoid arthritis	0.451	0.392	0.510
223	Osteoarthritis (mild)	0.216	0.171	0.268
224	Osteoarthritis (moderate)	0.415	0.357	0.474
225	Osteoarthritis (severe)	0.575	0.515	0.633
226	Low back pain (mild)	0.138	0.101	0.181
227	Low back pain (moderate)	0.310	0.257	0.368
228	Low back pain (severe)	0.456	0.396	0.517
229	Neck pain	0.133	0.097	0.177
230	Gout	0.390	0.332	0.451
231	Systemic lupus erythematosus	0.594	0.533	0.651
232	Neural tube defects	0.782	0.734	0.825

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Table 2. (Continued) Disability weights for 289 causes of disease

No.	Cause of disease	Disability weight	95% CI	
			Lower	Upper
233	Congenital heart anomalies	0.679	0.622	0.731
234	Cleft lip and cleft palate	0.313	0.258	0.372
235	Down's syndrome	0.590	0.533	0.645
236	Eczema	0.135	0.098	0.179
237	Psoriasis	0.235	0.187	0.288
238	Cellulitis	0.273	0.222	0.329
239	Abscess, impetigo, and other bacterial skin diseases	0.267	0.215	0.324
240	Scabies	0.194	0.150	0.245
241	Fungal skin diseases	0.260	0.210	0.316
242	Viral skin diseases	0.166	0.126	0.212
243	Acne vulgaris	0.049	0.029	0.078
244	Alopecia areata	0.154	0.114	0.200
245	Pruritus	0.100	0.069	0.140
246	Urticaria	0.106	0.074	0.147
247	Decubitus ulcer	0.479	0.421	0.536
248	Glaucoma	0.449	0.388	0.510
249	Cataracts	0.324	0.267	0.383
250	Macular degeneration	0.457	0.396	0.518
251	Refraction and accommodation disorders	0.206	0.162	0.257
252	Dental caries	0.065	0.042	0.097
253	Periodontal disease	0.206	0.161	0.257
254	Edentulism	0.471	0.410	0.531
255	Pedestrian injury by road vehicle	0.470	0.410	0.530
256	Road injury (pedal cycle vehicle)	0.315	0.262	0.371
257	Road injury (motorized vehicle with two wheels)	0.495	0.435	0.555
258	Road injury (motorized vehicle with three or more wheels)	0.597	0.538	0.653
259	Falls	0.165	0.126	0.212
260	Drowning	0.514	0.454	0.573
261	Fire, heat and hot substances	0.362	0.304	0.423
262	Poisonings	0.475	0.415	0.536
263	Mechanical forces (firearm)	0.547	0.485	0.608
264	Adverse effects of medical treatment	0.362	0.306	0.420
265	Animal contact (venomous)	0.363	0.304	0.424
266	Animal contact (non-venomous)	0.132	0.095	0.176
267	Self-harm	0.516	0.455	0.577
268	Assault by firearm	0.488	0.429	0.548
269	Assault by sharp object	0.260	0.212	0.312
270	Exposure to forces of nature	0.235	0.188	0.287
271	Collective violence and legal intervention	0.432	0.373	0.492
272	Allergic rhinitis	0.087	0.059	0.123
273	Atopic dermatitis	0.231	0.182	0.285
274	Metabolic syndrome	0.304	0.250	0.361
275	Allergic rhinitis and atopic dermatitis	0.166	0.124	0.215
276	Diabetes mellitus and osteoarthritis	0.495	0.436	0.553
277	Allergic rhinitis and asthma	0.187	0.145	0.236
278	Allergic rhinitis and osteoarthritis	0.192	0.147	0.244
279	Allergic rhinitis and major depressive disorder	0.394	0.336	0.453
280	Major depressive disorder and osteoarthritis	0.478	0.418	0.539
281	Diabetes mellitus and ischemic stroke	0.629	0.570	0.685
282	Diabetes mellitus and tuberculosis	0.478	0.418	0.539
283	Diabetes mellitus, osteoarthritis, and major depressive disorder	0.543	0.484	0.601
284	Diabetes mellitus, osteoarthritis, and ischemic stroke	0.667	0.611	0.719
285	Allergic rhinitis, asthma, and atopic dermatitis	0.172	0.131	0.219
286	Diabetes, osteoarthritis, and tuberculosis	0.574	0.514	0.632
287	Diabetes mellitus, osteoarthritis, rheumatoid arthritis	0.494	0.431	0.556
288	Full heath	0.000	0.000	0.000
289	Being dead	1.000	1.000	1.000

CI = confidence interval, *E. coli* = *Escherichia coli*.

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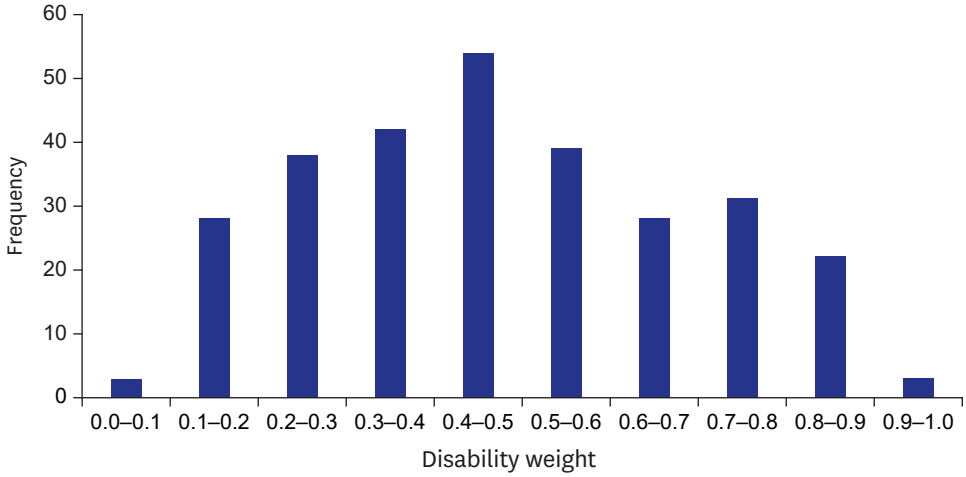

Fig. 1. Distribution of disability weights.

coefficient was 0.930. Among 211 overlapping causes of disease, the disability weights for 47 causes of disease from this study, such as 'tuberculosis' and 'decubitus ulcer,' were determined to be higher than that from the previous study; whereas, the disability weights for 163 causes of disease from this study, such as 'schizophrenia' and 'epilepsy,' were estimated to be lower than that from the previous study. The cause of disease with largest difference in disability weight between the two studies was 'falls (0.448)', followed by 'down's syndrome (0.318)' and 'asperger's syndrome (0.277).' **Supplementary Table 1** shows comparisons between the disability weights for overlapping causes of disease from this study and the previous study.[11]

The results of comparing the disability weights of 60 causes of disease that are more subdivided into severity are shown in the **Table 3.** In the case of 'liver cancer secondary to alcohol use,' the disability weights by stage were 0.603 (stage 1), 0.718 (stage 2), 0.785 (stage 3), and 0.876

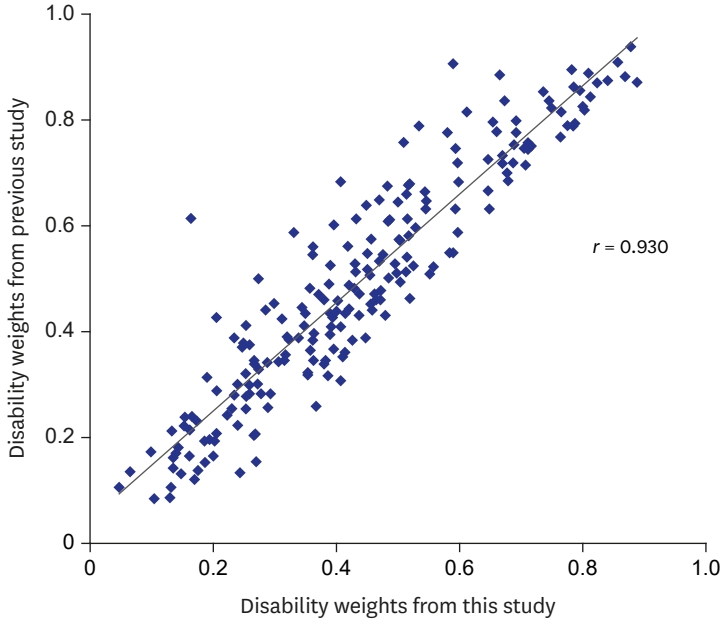

Fig. 2. Correlation of disability weights between this study and a previous study.

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Table 3. Comparison of disability weights among causes of disease subdivided by severity

Cause of disease	Disability weight from this study	95% CI		Disability weight from a previous study
		Lower	Upper	
Stomach cancer (stage 1)	0.462	0.403	0.520	0.724
Stomach cancer (stage 2)	0.669	0.614	0.720	
Stomach cancer (stage 3)	0.823	0.780	0.860	
Stomach cancer (stage 4)	0.880	0.840	0.912	
Liver cancer secondary to alcohol use (stage 1)	0.603	0.541	0.661	0.824
Liver cancer secondary to alcohol use (stage 2)	0.718	0.666	0.766	
Liver cancer secondary to alcohol use (stage 3)	0.785	0.737	0.827	
Liver cancer secondary to alcohol use (stage 4)	0.876	0.838	0.907	
Trachea, bronchus and lung cancers (stage 1)	0.600	0.542	0.656	0.917
Trachea, bronchus and lung cancers (stage 2)	0.738	0.686	0.785	
Trachea, bronchus and lung cancers (stage 3)	0.758	0.710	0.801	
Trachea, bronchus and lung cancers (stage 4)	0.906	0.873	0.932	
Breast cancer (stage 1)	0.439	0.379	0.500	0.704
Breast cancer (stage 2)	0.597	0.535	0.657	
Breast cancer (stage 3)	0.724	0.671	0.771	
Breast cancer (stage 4)	0.864	0.826	0.895	
Cervical cancer (stage 1)	0.431	0.372	0.491	0.744
Cervical cancer (stage 2)	0.553	0.493	0.611	
Cervical cancer (stage 3)	0.813	0.767	0.851	
Cervical cancer (stage 4)	0.855	0.815	0.889	
Prostate cancer (stage 1)	0.458	0.399	0.518	0.701
Prostate cancer (stage 2)	0.613	0.552	0.672	
Prostate cancer (stage 3)	0.742	0.692	0.787	
Prostate cancer (stage 4)	0.838	0.795	0.874	
Colon and rectum cancers (stage 1)	0.496	0.436	0.556	0.759
Colon and rectum cancers (stage 2)	0.689	0.631	0.742	
Colon and rectum cancers (stage 3)	0.841	0.798	0.878	
Colon and rectum cancers (stage 4)	0.870	0.833	0.900	
Kidney cancer (stage 1)	0.570	0.509	0.627	0.777
Kidney cancer (stage 2)	0.731	0.678	0.778	
Kidney cancer (stage 3)	0.809	0.762	0.849	
Kidney cancer (stage 4)	0.902	0.870	0.927	
Bladder cancer (stage 1)	0.500	0.441	0.558	0.792
Bladder cancer (stage 2)	0.623	0.567	0.676	
Bladder cancer (stage 3)	0.769	0.720	0.812	
Bladder cancer (stage 4)	0.869	0.830	0.901	
Thyroid cancer (stage 1)	0.301	0.248	0.359	0.466
Thyroid cancer (stage 2)	0.484	0.425	0.543	
Thyroid cancer (stage 3)	0.639	0.583	0.691	
Thyroid cancer (stage 4)	0.779	0.730	0.822	
Ischemic stroke (mild)	0.540	0.477	0.601	0.809
Ischemic stroke (moderate)	0.787	0.740	0.828	
Ischemic stroke (severe)	0.840	0.799	0.875	
Chronic obstructive pulmonary disease (mild)	0.408	0.351	0.466	0.690
Chronic obstructive pulmonary disease (moderate)	0.703	0.648	0.754	
Chronic obstructive pulmonary disease (severe)	0.722	0.668	0.771	
Cirrhosis of the liver secondary to alcohol use (mild)	0.484	0.424	0.543	0.614
Cirrhosis of the liver secondary to alcohol use (moderate)	0.668	0.612	0.722	
Cirrhosis of the liver secondary to alcohol use (severe)	0.717	0.664	0.765	
Major depressive disorder (mild)	0.279	0.229	0.333	0.606
Major depressive disorder (moderate)	0.528	0.469	0.586	
Major depressive disorder (severe)	0.569	0.509	0.627	
Diabetes mellitus without complications	0.334	0.279	0.391	0.593
Diabetes mellitus with complications	0.663	0.605	0.717	
Osteoarthritis (mild)	0.216	0.171	0.268	0.370
Osteoarthritis (moderate)	0.415	0.357	0.474	
Osteoarthritis (severe)	0.575	0.515	0.633	

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Table 3. (Continued) Comparison of disability weights among causes of disease subdivided by severity

Cause of disease	Disability weight from this study	95% CI		Disability weight from a previous study
		Lower	Upper	
Low back pain (mild)	0.138	0.101	0.181	0.315
Low back pain (moderate)	0.310	0.257	0.368	
Low back pain (severe)	0.456	0.396	0.517	

CI = confidence interval.

(stage 4). The disability weight of 'liver cancer secondary to alcohol use' in the previous study was 0.824, located between the stage 3 and 4. On the other hand, in the case of 'thyroid cancer,' the disability weights by stage were 0.301 (stage 1), 0.484 (stage 2), 0.639 (stage 3), and 0.779 (stage 4). The disability weight of 'thyroid cancer' in the previous study was 0.466, located between the stage 1 and 2. Furthermore, the disability weight of 'diabetes mellitus without complications' was 0.334, but the disability weight of 'diabetes mellitus with complications' was 0.663, with a difference of 0.329.

DISCUSSION

In this study, we have amended 289 disability weights for causes of disease adapting the methodology of the KBD disability weight 2012 study.[11] In particular, we divided the severity of major causes of diseases unlike KBD disability weight 2012 study and estimated their disability weights. A significant number of physicians and medical students participated in the disability weight survey to collect professional and objective opinions on the preferences of the causes of diseases. Furthermore, we maximized the efficiency of the collecting data by using a method ranking five causes of disease that has not yet been attempted in disability weight studies.

In the meantime, paired comparison has been used as a key value evaluation method in the latest international and domestic disability weight studies.[11,13-15] In this study, however, the ranking method was used as a valuation method, and we determined that the ranking method could be used to calculate the disability weight. Paired comparison has a disadvantage in that the amount of information that can be obtained from a single question is limited, so that the number of items in the survey or the sample size must be increased, if the number of health states or causes of disease to be compared is large.[12,17] Although the utilization of the ranking method is still low, it can provide more information than the paired comparison. Based on the experience of this study, we expected that the use of the ranking method will increase gradually.

Another difference from previous studies is that we estimated disability weights considering the severity of the causes of disease. We calculated the disability weights of 60 causes of disease considering severity level and compared them with the disability weights in the previous study.[11] These results show that prejudice about the severity of cause of disease itself can affect the estimation of disability weight, when estimating the disability weight of cause disease without consideration of severity. For example, disability weight of 'liver cancer secondary to alcohol use' by stage were 0.603 (stage 1), 0.718 (stage 2), 0.785 (stage 3), and 0.876 (stage 4). The disability weight of 'liver cancer secondary to alcohol use' in the previous study was 0.824, located between the stage 3 and 4 (11). On the other hand, disability weight of 'thyroid cancer' by stage were 0.301 (stage 1), 0.484 (stage 2), 0.639 (stage 3), and 0.779

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(stage 4). The disability weight of 'thyroid cancer' in the previous study was 0.466, located between the stage 1 and 2.[11] These results suggest that it is necessary to calculate the disability weight of causes of disease by reflecting the severity in order to calculate the valid DALY in cases of the large severity difference in the cause of disease or the burden of disease is large. However, in this case, epidemiological data according to severity should be also collected to estimate valid DALY.[18,19]

When conducting a disability weight study, we typically estimate disability weights for dozens to hundreds of health states or causes of disease, and the calculated disability weight has a value of a limited scale of 0 to 1. Thus, a disability weight for any health state or cause of disease may seem counterintuitive when compared to other health state or cause of disease's disability weight, and the absolute magnitude of the disability weight may not seem plausible. This will be the same in this study. However, since there is no golden standard for disability weights, it is not easy to assess the validity of disability weights.[12,17]

In this study, the following indirect methods were used to evaluate and enhance the validity of the disability weights. First, we examined whether disability weights were reversed in diseases with different levels of severity. For example, when the severity of an ischemic stroke is classified as mild, moderate, or severe, the disability weight of the mild ischemic stroke should be the lowest, and the disability weight of the severe ischemic stroke should be the highest. No such reversal was found in this study. We also tried to compare the disability weights of the present study with the disability weights calculated in a previous study.[11] As a result, it was confirmed that there was a fairly high correlation between disability weights from the two studies. Finally, we tried to increase the number of survey participants and to include various specialist among survey participants. Compared to the size of other studies' samples,[17] a significant number of medical professionals have participated in this disability weights survey.

In the recent disability weighting study, the general public is used rather than the healthcare professionals as a participant in the questionnaire.[13-15] Considering that the reason for estimating the disability weight is to measure the burden of disease and one of the main reasons for measuring the burden of disease is to determine the priority of resource allocation, it is persuasive to calculate disability weights reflecting the preferences of the general public.[12,20,21] However, it is not easy to precisely get preferences for health states or causes of disease among the general public who do not have a lot of medical knowledge.[12,22] It is therefore still worthwhile to utilize healthcare professionals in disability weights studies who are expected to be able to objectively compare and evaluate causes of disease with a wealth of knowledge of various health states and causes of diseases.[11] It is expected that comparing and integrating the results of the disability weights studies for healthcare professionals, patients, and the general public will become increasingly important.

One limitation of this study is that it could not perform the verification of the disability weight model of multimorbidity properly. We included 16 causes of disease, such as diabetes mellitus with osteoarthritis, in the list of causes of disease and tried to preliminarily evaluate the validity of multiplicative model, additive model, and maximum model for disability weights in multimorbidity.[22,23] However, it seems that the meaning of having a complex disease in the survey participants is not enough. As a result, there were some cases in which the disability weight did not increase despite the increased number of cause of disease. For example, the disability weights of 'allergic rhinitis' and 'atopic dermatitis' were 0.087 and

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0.231, respectively, but the disability weight was estimated to be 0.166 for both of these causes of disease. In order to validate the disability weight model in multimorbidity, further studies are needed considering the level of understanding of participants.

Another limitation is that physicians and medical students participating in the survey may not represent the preference for disease among all medical professionals. However, we tried to increase the number of survey participants and to include various specialist among survey participants. Therefore, it is expected that the disability weight derived from this study will not be significantly different from the judgment of the degree of disability of all medical professionals. Future disability weight studies need to involve more medical professionals with various specialties in the survey.

In conclusion, we have estimated 289 disability weights for causes of disease adapting the methodology of the KBD disability weight 2012 study. The disability weights estimated based on the severity can be used to estimate the more accurate burden of diseases. Furthermore, the disability weights from this study can be utilized to estimate health life expectancy, especially HALE, in Korea.

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SUPPLEMENTARY MATERIAL

Supplementary Table 1

Comparison of disability weights for overlapping causes of disease between this study and a previous study

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REFERENCES

1. Murray CJ, Salomon JA, Mathers C. A critical examination of summary measures of population health. *Bull World Health Organ* 2000;78(8):981-94.
PUBMED
2. Hyder AA, Puvanachandra P, Morrow RH. Measuring the health of populations: explaining composite indicators. *J Public Health Res* 2012;1(3):222-8.
PUBMED | CROSSREF
3. Oh IH, Yoon SJ, Kim EJ. The burden of disease in Korea. *J Korean Med Assoc* 2011;54(6):646-52.
PUBMED | CROSSREF
4. Vos T, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017;390(10100):1211-59.
PUBMED | CROSSREF
5. Ock M, Han JW, Lee JY, Kim SH, Jo MW. Estimating quality-adjusted life-year loss due to noncommunicable diseases in Korean adults through to the year 2040. *Value Health* 2015;18(1):61-6.
PUBMED | CROSSREF

6. Jo MW, Seo W, Lim SY, Ock M. The Trends in Health Life Expectancy in Korea according to Age, Gender, Education Level, and Subregion: Using Quality-Adjusted Life Expectancy Method. *J Korean Med Sci* 2019;34 Suppl 1:e88.
CROSSREF
7. Yoon J, Oh IH, Seo H, Kim EJ, Gong YH, Ock M, et al. Disability-adjusted life years for 313 disease and injuries: the 2012 Korean Burden of Disease Study. *J Korean Med Sci* 2016;31 Suppl 2:S146-57.
PUBMED | CROSSREF
8. Lee JY, Ock M, Kim SH, Go DS, Kim HJ, Jo MW. Health-adjusted life expectancy (HALE) in Korea: 2005–2011. *J Korean Med Sci* 2016;31 Suppl 2:S139-45.
PUBMED | CROSSREF
9. Gong YH, Yoon SJ, Jo MW, Kim A, Kim YA, Yoon J, et al. The burden of cancer in Korea during 2012: findings from a prevalence-based approach. *J Korean Med Sci* 2016;31 Suppl 2:S168-77.
PUBMED | CROSSREF
10. Lee WK, Lim D, Park H. Disability-adjusted life years (DALYs) for injuries using death certificates and hospital discharge survey by the Korean burden of disease study 2012. *J Korean Med Sci* 2016;31 Suppl 2:S200-7.
PUBMED | CROSSREF
11. Ock M, Lee JY, Oh IH, Park H, Yoon SJ, Jo MW. Disability weights measurement for 228 causes of disease in the Korean burden of disease study 2012. *J Korean Med Sci* 2016;31 Suppl 2:S129-38.
PUBMED | CROSSREF
12. Ock M, Ko S, Lee HJ, Jo MW. Review of issues for disability weight studies. *Health Policy Manag* 2016;26(4):352-8.
CROSSREF
13. Salomon JA, Haagsma JA, Davis A, de Noordhout CM, Polinder S, Havelaar AH, et al. Disability weights for the Global Burden of Disease 2013 study. *Lancet Glob Health* 2015;3(11):e712-23.
PUBMED | CROSSREF
14. Haagsma JA, Maertens de Noordhout C, Polinder S, Vos T, Havelaar AH, Cassini A, et al. Assessing disability weights based on the responses of 30,660 people from four European countries. *Popul Health Metr* 2015;13(1):10.
PUBMED | CROSSREF
15. Ock M, Ahn J, Yoon SJ, Jo MW. Estimation of disability weights in the general population of South Korea using a paired comparison. *PLoS One* 2016;11(9):e0162478.
PUBMED | CROSSREF
16. Ock M, Yi N, Ahn J, Jo MW. How many alternatives can be ranked? A comparison of the paired comparison and ranking methods. *Value Health* 2016;19(5):655-60.
PUBMED | CROSSREF
17. Haagsma JA, Polinder S, Cassini A, Colzani E, Havelaar AH. Review of disability weight studies: comparison of methodological choices and values. *Popul Health Metr* 2014;12(1):20.
PUBMED | CROSSREF
18. Ock M, Jo MW, Gong YH, Lee HJ, Lee J, Sim CS. Estimating the severity distribution of disease in South Korea using EQ-5D-3L: a cross-sectional study. *BMC Public Health* 2016;16(1):234.
PUBMED | CROSSREF
19. Burstein R, Fleming T, Haagsma J, Salomon JA, Vos T, Murray CJ. Estimating distributions of health state severity for the global burden of disease study. *Popul Health Metr* 2015;13(1):31.
PUBMED | CROSSREF
20. Dolan P, Olsen JA, Menzel P, Richardson J. An inquiry into the different perspectives that can be used when eliciting preferences in health. *Health Econ* 2003;12(7):545-51.
PUBMED | CROSSREF
21. Salomon JA, Vos T, Hogan DR, Gagnon M, Naghavi M, Mokdad A, et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *Lancet* 2012;380(9859):2129-43.
PUBMED | CROSSREF
22. Haagsma JA, van Beeck EF, Polinder S, Toet H, Panneman M, Bonsel GJ. The effect of comorbidity on health-related quality of life for injury patients in the first year following injury: comparison of three comorbidity adjustment approaches. *Popul Health Metr* 2011;9(1):10.
PUBMED | CROSSREF
23. Hilderink HB, Plasmans MH, Snijders BE, Boshuizen HC, Poos MJ, van Gool CH. Accounting for multimorbidity can affect the estimation of the Burden of Disease: a comparison of approaches. *Arch Public Health* 2016;74(1):37.
PUBMED | CROSSREF