

# BMJ Open Healthcare utilisation and costs for temporomandibular disorders: a descriptive, cross-sectional study

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## ABSTRACT

**Objective** Temporomandibular joint disorder (TMD) requires long-term management and can be a financial burden for patients. Here, we investigated the treatment received by people diagnosed with TMD and its relevant costs.

**Design** A descriptive, cross-sectional study.

**Setting and participants** We performed secondary data analysis of health insurance claims data provided by the Health Insurance Assessment and Review (HIRA) of the Republic of Korea. We reviewed the records of 10 041 patients who were diagnosed with TMD and who utilised outpatient healthcare service at least once between January and December 2017.

**Primary and secondary outcome measures** Data on use of medical services, hospitalisations, sociodemographic factors, treatment and medication were retrieved and analysed. Cost was defined as the cost of care incurred by a health insurance beneficiary at a care facility.

**Results** We reported the characteristics as medians, frequencies and percentages and found that most TMD patients were outpatients, women (58.9%) and in their 20s (46.4%). For visit type, 85.9% of all patients had an outpatient dental medical visit, with most visiting dental clinics and dental hospitals. Western medicine (WM; 9.8%) was prescribed more often, followed by Korean medicine (KM; 8.2%). The median expense per patient was highest among those in their 20s (58.00, 23.90, 53.40, 65.90 US\$ for overall, WM, dental medicine (DM) and KM, respectively). Consultation fees accounted for the greatest percentage (42.8%) of DM and WM care expenses, while injection/non-surgical intervention fees accounted for the greatest percentage of KM care expenses. The most commonly used treatments for TMD were temporomandibular joint stimulation therapy (51.1%) and acupuncture (19.9%), considered as the most basic care for TMD. Psychosomatic agents (86.4%) were the most commonly used medications in outpatients.

**Conclusions** While people with TMD most commonly received temporomandibular stimulation therapy, the costs and duration of treatment varied significantly for these patients.

## INTRODUCTION

The temporomandibular joint (TMJ) is one of the most frequently used joints in the

## Strengths and limitations of this study

- A major strength of this study lies in its large sample size, which was based on nationwide health insurance claims data.
- This is the first study to investigate the current status of temporomandibular joint disorder in Korea, including the use of Western medicine, dental medicine and Korean medicine.
- Because inpatient admissions were considered to be due to major injuries or invasive surgery and the number of inpatients was small, we were unable to analyse inpatient data in detail.
- Non-covered care and over-the-counter drugs were not included in the Health Insurance Review and Assessment–National Patient Sample claims data, and the use of secondary data such as claims data may lead to diagnostic inaccuracies.
- Because we used the only 2017 claim data, patients could not be followed-up over time.

human body.<sup>1</sup> It is a complex synovial joint enveloped by a joint capsule and consists of articulations between the mandibular fossa and articular tubercle of the temporal bone and the articular process of the mandible.<sup>2</sup> Temporomandibular disorders (TMD) are diseases involving structural or functional impairments of TMJ-related structures,<sup>3</sup> and they may be accompanied by various symptoms including myofascial tenderness and pain, headache, joint noises, trismus and even tinnitus.<sup>4</sup> Although the prevalence of TMD varies depending on the target population, definition and research methodology, it remains high at 11%–50%.<sup>5</sup> TMD is also known to frequently affect women and people in their 20s–40s.<sup>6</sup> A study based on the Korea National Health and Nutrition Examination Survey reported a prevalence of 3.1% among TMD patients with persistent symptoms for ≥3 months.<sup>7</sup> According to an analysis of 2010–2015 health insurance payout data by the National Health Insurance Service (NHIS), the number of patients who received care

with TMD as the main diagnosis increased by 40.5%—from 250 000 in 2010 to 3 50 000 in 2015.<sup>8</sup>

TMD is perceived not as an acute or fatal disorder but as a self-limiting, chronic and complex dental disease with diverse symptoms caused by several factors.<sup>9</sup> Chronic TMD is also known to have strong correlations with other medical conditions including headache, low back pain, joint pain, abdominal pain and mental disorders.<sup>10–12</sup> Therefore, TMD requires long-term management, along with consideration to various pain-related conditions as well as mental health issues. For this reason, TMD patients are likely to be financially burdened in the long term. In fact, prior studies have reported that insurance claim costs incurred by TMD patients are nearly twice as those incurred by non-TMD patients.<sup>13</sup>

Despite the difficult reality faced by TMD patients, research on medical costs and specific medical utilisation regarding TMD is lacking. Only one study has investigated the healthcare utilisation by TMD patients in Korea,<sup>14</sup> but it did not assess the medical cost for each claimed item nor captured the specific details of care. Given this dearth of information, our study aimed to examine the current status of TMD treatment and its relevant costs in Korea, by analysing claims data from the Health Insurance Review and Assessment (HIRA) National Patient Sample (NPS) data set.

## METHODS

### Data source

We analysed health insurance claims data from the 2017 HIRA–NPS data set. Health insurance claims data are generated when healthcare facilities make insurance benefit claims with the HIRA after providing medical services to patients. Claims data contain massive amounts of diverse information including details of care (eg, treatment, procedure, examination, prescription), diagnosis, insurer's payment, patient's out-of-pocket cost, patient population demographics and information about the care provider, which are highly valuable for healthcare research. The HIRA provides annual sample data that can be extracted via random stratified sampling to ensure researchers' access to data and convenience. The extracted secondary data exclude personally identifiable and corporate information from the raw data and contain insurance claims over a 1-year period from the date of care initiation for the corresponding year. Patients who utilised medical services over a 1-year period were selected using a systematic, stratified sampling method, by sex and age group (5-yearly units) and their details of care and prescriptions are provided.<sup>15</sup> As of 2017, 3% of the entire patient population, which was about 1.45 million people, were included in the data set.<sup>16</sup>

In some countries where traditional medicine is practiced as a whole medical system, such as with the traditional Chinese medicine or Ayurveda, both conventional medicine and traditional medicine exist as independent medical systems.<sup>17</sup> South Korea also has a unique

healthcare system where Korean traditional medicine and Western medicine (including dental medicine) exist on equal terms with exclusive practice boundaries.<sup>18</sup> Moreover, South Korea does not exploit the family physician system, which means that the patients are free to select their primary care centres among a multitude of clinics and hospitals.

### Patient and public involvement

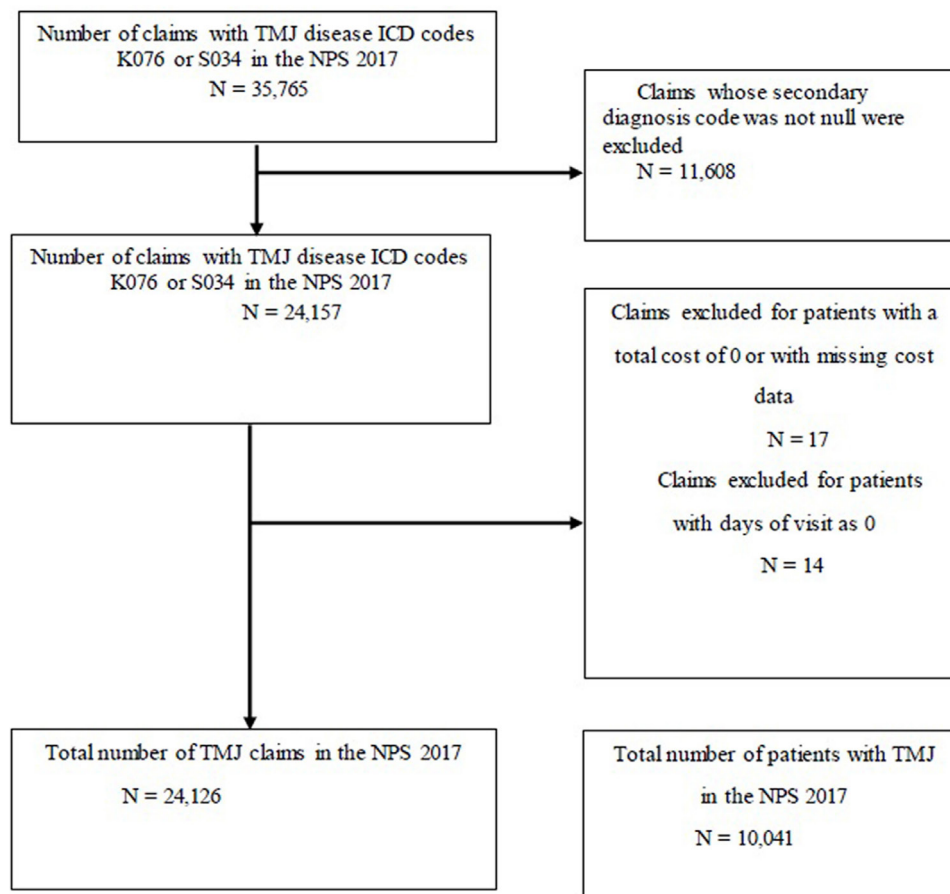
There was no direct patient or public involvement in this review.

### Study design and population

We performed a cross-sectional, descriptive study analysing patients who were diagnosed with TMD in Korea and utilised medical services at least once between January and December 2017. While previous studies have used the Research Diagnostic Criteria for TMD<sup>19</sup> or self-reported surveys<sup>20</sup> to diagnose TMD, limited studies have used ICD codes in administrative data. In this study, our research team operationally defined TMD as cases with an International Statistical Classification of Disease and Related Health Problems, 10th revision (ICD-10) code of K07.6 (TMJ disorders) or S03.4 (sprain and strain of jaw) as the main diagnosis under outpatient care.

Claims data provided by the HIRA included raw data on treatment prescriptions for all patients who received medical services over the course of 1 year. The raw data did not contain personal and corporate information. Because the claims were submitted monthly, charges in the statement reflected up to 1 month of information. In other words, patients who had been hospitalised for >1 month would have been charged separately for each month. In such cases, errors such as overestimation of the number of inpatients and underestimation of medical expenses might occur when performing statistical analyses. Therefore, data on hospitalisation episodes, which involved collecting and calibrating several claims charged monthly for one consecutive medical practice, were used. In this study, separate claim forms of hospitalised patients were bundled into one hospitalisation episode. Variables used in the episode creating process included claims identification key, patient identification key, insurance type, main diagnostic code, treatment type, treatment start date and treatment end date.

Figure 1 shows the study participant selection process. Of the 35 765 claims of patients who visited the hospital with a K07.6 or S03.4 diagnostic code in 2017, a total of 11 608 claims whose secondary diagnostic code was not null were excluded. Additionally, 17 claims with zero total costs or missing cost data were also excluded, as well as 14 claims in which the number of days of visit was 0. Therefore, a total of 24 126 claims and 10 041 patients were included in the final analysis. Among 10 141 patients, there were only nine inpatient admissions, which were considered to be due to major injuries or invasive surgery. Because of such small sample size, these data might not accurately represent the actual number of TMD inpatients, so we



**Figure 1** Participant flow diagram. ICD-10, International Statistical Classification of Disease and Related Health Problems, 10th revision; NPS, National Patient Sample; TMJ, temporomandibular joint.

did not analyse inpatient data in detail. Moreover, a single patient can be included as both inpatient and outpatient.

### Data analysis

TMD patients were classified by age (eight categories of 10-yearly units, from 0 to 9 years to  $\geq 70$  years), sex, payer type (health insurance, medical aid and other), surgery, visit type (Western, dental and Korean medicine inpatient or outpatient; public health centre inpatient or outpatient), medical specialty and type of healthcare institution, and the frequency of each characteristic was analysed. In Korea, the payment system is fee-for-service based on the National Health Insurance (NHI) system. According to the HIRA guidelines under the Ministry of Health and Welfare (MOHW),<sup>15</sup> the total cost is based on the following 11 categories: outpatient visit (consultation), hospital admission, medication, injection/non-surgical intervention, anaesthesia, physiotherapy, psychotherapy, treatment and surgery, examination and radiographic evaluation/intervention. In this study, among the 11 categories, the number of ‘uses of special equipment’ was very small; therefore, only the 10 practices were used as the criteria. Previous studies using HIRA–NPS data in Korea followed these 10 classification criteria.<sup>21 22</sup> Cost was defined as the cost of care incurred by a health insurance beneficiary at a care facility, which

is the sum of the NHIS-covered cost and the patient’s out-of-pocket cost. This was determined by review of the total cost of care claimed by a care facility.

We analysed the frequencies of billing codes for procedures such as injection/non-surgical interventions, physiotherapy and surgery, and listed them in order from the highest to the lowest frequency. We only included items determined to be directly relevant to TMD care on discussion and review among our team.

Drug codes assigned during inpatient and outpatient care were classified according to the MOHW protocol and were listed according to frequency of use for TMD treatment. Each drug was classified according to Anatomical Therapeutic Chemical (ATC) codes within the MOHW classification criteria shown in online supplemental table 1, to additionally analyse frequently used codes. Published in 1976, the ATC Classification System has been used to classify drugs and medical products and is being managed by the WHO Collaborating Centre for Drug Statistics Methodology.<sup>22</sup>

### Statistical analyses

The patients’ demographic characteristics and medical service-related details, including payer type, surgery, facility visit type, medical specialty, medical institution type, medication, injection, anaesthesia, physiotherapy,

**Table 1** General medical service use for patients with temporomandibular joint disorder in Korea

Type of visit		Number of patients*	Number of cases*	Total expense†	Per-patient expense†	Per-case expense†	Average days in care‡	Average days in visits§
Total	Total	10 041	24 126	721 447.5	71.9	29.9	2.4	2.4
	K076	9571	22 915	696 483.4	72.8	30.4	2.4	2.4
	S034	576	1211	24 964.1	43.3	20.6	2.1	2.1
Inpatients	Total	9	9	4750.5	527.8	527.8	7.4	2.2
	K076	8	8	4609.6	576.2	576.2	8.3	2.4
	S034	1	1	140.9	140.9	140.9	1.0	1.0
Outpatients	Total	10 040	24 117	716 697.1	71.4	29.7	2.4	2.4
	K076	9570	22 907	691 873.8	72.3	30.2	2.4	2.4
	S034	575	1210	24 823.2	43.2	20.5	2.1	2.1

\*If a patient had multiple diagnostic codes, the most frequent code was indicated. Only one person had both K076 and S034 codes.

†Amount presented in US\$. 1 US\$=1086 KRW (average rate in December 2017).

‡Average days in care: the number of total treatment days denoted in the claims statement including days with drug prescription without medical treatment.

§Average days of visits: the number of outpatient visits or the number of inpatient care days indicated in the claims statement.

psychotherapy, procedure/surgery, examination and radiographic evaluation/intervention, were reported as frequencies and percentages according to inpatient/outpatient status, particularly whether the patient was an Western medicine outpatient, dental medicine outpatient or Korean medicine outpatient. For medical expenses, the medical cost per category, percentage of costs for each category and medical cost per claim or per patient were computed. Analyses were conducted using the SAS package V.9.4 (SAS Institute, Cary, NC, USA).

## RESULTS

### General medical services use for TMD patients in Korea

There were two main diagnostic codes for TMD (K076 and S034), and the number of patients, number of claims, total cost, per-patient cost, per-claim cost, average days in care and average number of hospital visits were compared between the inpatient and outpatient groups (table 1). In 2017, a total of 10 041 patients received care for TMD as the main diagnosis. A total of 10 041 patients, including nine inpatients, received outpatient care and those with the code K076 accounted for most of our sample. The number of patients, total cost, per-patient cost, per-claim cost, average days in care and average days of visit were all higher with the code K076 than with the code S034.

The total cost was 721 447.5 US\$ (average conversion rate in December 2017: 1 US\$=1086 KRW). From this cost, 4750.5 US\$ was spent on inpatient care and the rest on outpatient care. The cost of inpatient care was 7.4 times higher than that for outpatient care, at an average of 71.4 and 527.8 US\$ for outpatients and inpatients, respectively. Only one patient was hospitalised under the code S034. Among those with S034 as the main diagnosis, the average days in care and the average days of visit were 2.1 times higher for outpatients.

### General characteristics

The characteristics of the TMD patients are shown in table 2A,B. The majority of patients were in their 20s, and this age group also had the highest total number of days of care. TMD frequency tended to decrease with advancing age after the age of 30–39 years. At three visits, the average number of days in care was highest among patients aged  $\geq 70$  years. It was lowest among patients aged 0–9 years at 1.6 days. Average expense was highest and lowest among patients aged 20–29 and  $\geq 70$  years, respectively. The greatest expense was 1584.7 US\$ among patients in their 30s.

Most of the patients were women (58.9%), who had a higher average number of days in care than men (table 2A). Women also incurred more expenses than men did when the mean expenses were compared by sex (95.50 vs 73.00 US\$), and the maximum expense was incurred by a female patient (1584.7 US\$). There were differences in mean expense per patient (male: 73.0 US\$ vs female: 95.3 US\$) and between sexes. Data on insurance type, surgery, visit type, medical specialty and medical institution type are shown in table 2B.

### Distribution of medical expenditures

The distribution of medical expenditures in TMD according to medical practice type is detailed in table 3. Outpatient visit expenses accounted for the greatest proportion of all expenditures (35.4%), followed by treatment and surgery (20.5%), radiographic evaluation/intervention (18.1%) and injection/non-surgical intervention (16.3%). Outpatient visit fees accounted for 40.6%, 38.2% and 24.2% of all medical expenses in Western, dental and Korean medicine, respectively.

From the total medical expenditure of 643 867.2 US\$ spent by the entire patient population, 42.8% was spent on outpatient visit fees. Outpatient visit fees accounted for



**Table 2A** General characteristics of patients with diagnostic codes indicating temporomandibular joint disorder in Korea

Category		Patient		Visit count		Mean	SD	Min	Max
		Total N (10 041)	%	Total N (24 126)	%				
Age	0–9	99	1.0	158	0.7	1.6	2.5	1	19
	10–19	1813	18.1	4373	18.1	2.4	3.1	1	29
	20–29	2737	27.3	6200	25.7	2.3	3.0	1	48
	30–39	1570	15.6	3482	14.4	2.2	2.8	1	31
	40–49	1329	13.2	3028	12.6	2.3	3.1	1	50
	50–59	1137	11.3	3086	12.8	2.7	6.0	1	108
	60–69	782	7.8	2103	8.7	2.7	4.2	1	51
	≥70	574	5.7	1696	7.0	3.0	5.2	1	63
Sex	Male	4128	41.1	8587	35.6	2.1	3.1	1	108
	Female	5913	58.9	15 539	64.4	2.6	4.0	1	108
Payer type*	NHI	9790	97.5	23 583	97.7	2.4	3.7	1	108
	MD	255	2.5	522	2.2	2.0	2.3	1	16
	Others	4	0.0	21	0.1	5.3	4.3	1	11
Surgery†	No	9970	99.3	24 034	99.6	2.4	3.7	1	108
	Yes	71	0.7	92	0.4	1.3	0.9	1	6
Visit type	WM IP	1	0.0	1	0.0	1.0	–	1	1
	WM OP	980	9.8	1491	6.2	1.5	1.8	1	22
	DM IP	7	0.1	7	0.0	1.0	–	1	1
	DM OP	8627	85.9	18 565	77.0	2.2	2.8	1	108
	PHC IP	–	–	–	–	–	–	–	–
	PHC OP	15	0.1	33	0.1	2.2	1.5	1	6
	KM IP	1	0.0	1	0.0	1.0	–	1	1
	KM OP	825	8.2	4028	16.7	4.9	7.7	1	108
Medical specialty	CD	4309	42.9	7604	31.5	1.8	2.6	1	108
	OM	2133	21.2	5990	24.8	2.8	3.1	1	45
	OMS	2566	25.6	4250	17.6	1.7	2.0	1	48
	IKM	432	4.3	2234	9.3	5.2	9.0	1	108
	AMM	356	3.5	1620	6.7	4.6	5.8	1	50
	OS	405	4.0	648	2.7	1.6	1.9	1	22
Medical institution type	TH	714	7.1	1705	7.1	2.4	4.9	1	107
	Hospital	93	0.9	128	0.5	1.4	1.4	1	11
	Clinic	823	8.2	1260	5.2	1.5	1.8	1	22
	DM hospital	1669	16.6	3958	16.4	2.4	2.4	1	25
	DM clinic	6656	66.3	12 995	53.9	2.0	2.5	1	48
	KM hospital	70	0.7	222	0.9	3.2	3.6	1	22
	KM clinic	757	7.5	3809	15.8	5.0	8.0	1	108
	Others	30	0.3	49	0.2	1.6	1.2	1	6

\*Others, national free medical treatment or veteran healthcare.

†Surgery was counted as 'once' if a patient had at least one surgery performed.

AMM, acupuncture and moxibustion medicine; CD, conservative dentistry; DM, dental medicine; GH, general hospital; IKM, internal Korean medicine; IP, inpatient; KM, Korean medicine; LCH, long-term care hospital; MD, medicaid; NHI, national health insurance; OM, oral medicine; OMS, oral and maxillofacial surgery; OP, outpatient; OS, orthopaedic surgery; PHC, public health centre; TH, tertiary hospital; WM, western medicine.



**Table 2B** Expenses of patients with diagnostic codes indicating temporomandibular joint disorder in Korea

Category	Patient					Expense per patient*						
	Total N (10 041)	%	Mean	SD	Min	Median	Max	Mean	SD	Min	Median	Max
Age												
0-9	99	1.0	23.4	15.4	8.3	19.8	111.4	39.2	56.8	8.3	21.2	412.7
10-19	1813	18.1	29.7	24.9	3.7	22.1	319.5	84.2	102.0	3.7	46.0	974.3
20-29	2737	27.3	33.8	28.8	3.7	23.0	327.8	88.0	107.9	3.7	58.0	2109.1
30-39	1570	15.6	32.6	43.3	3.7	23.0	1584.7	88.6	134.9	3.7	50.7	1806.5
40-49	1329	13.2	29.1	25.6	3.7	21.2	226.5	80.9	99.6	3.7	40.5	777.8
50-59	1137	11.3	27.6	24.7	3.7	19.3	308.5	89.8	140.1	3.7	43.3	1817.2
60-69	782	7.8	25.3	24.3	3.7	17.5	322.3	90.0	126.0	6.4	41.4	1146.2
≥70	574	5.7	22.8	24.5	3.7	14.7	385.8	85.7	134.7	4.6	36.9	954.4
Sex												
Male	4128	41.1	29.7	25.9	3.7	21.2	385.8	73.0	93.6	3.7	37.8	1817.2
Female	5913	58.9	30.0	31.1	3.7	20.3	1584.7	95.4	130.7	3.7	55.2	2109.1
Payer type†												
NHI	9790	97.5	29.9	29.5	3.7	21.2	1584.7	86.6	118.0	3.7	47.9	2109.1
MD	255	2.5	29.1	23.5	4.6	23.0	172.2	73.2	88.2	4.6	31.4	520.5
Others	4	0.0	22.4	8.4	10.1	26.7	41.4	242.3	399.8	27.7	80.0	954.4
Surgery‡												
No	9970	99.3	29.5	25.7	3.7	21.2	378.5	85.1	114.2	3.7	47.0	2109.1
Yes	71	0.7	130.3	209.4	16.6	109.6	1584.7	276.0	320.8	16.6	146.9	1806.5
Visit type												
WM IP	1	0.0	140.9	-	140.9	140.9	140.9	140.9	0.0	140.9	140.9	140.9
WM OP	980	9.8	20.0	15.7	3.7	16.6	378.5	46.0	69.4	7.4	23.9	725.1
DM IP	7	0.1	643.9	538.6	308.5	333.3	1584.7	885.7	521.7	385.8	684.9	1806.5
DM OP	8627	85.9	32.7	28.6	3.7	23.0	327.8	86.5	112.9	3.7	53.4	2109.1
PHC IP	-	-	-	-	-	-	-	-	-	-	-	-
PHC OP	15	0.1	5.6	2.2	3.7	102.2	12.0	30.7	53.8	4.6	11.0	214.6
KM IP	1	0.0	102.2	-	102.2	19.3	102.2	170.3	0.0	170.3	170.3	170.3
KM OP	825	8.2	19.7	5.8	7.4	140.9	55.2	124.7	162.6	7.4	65.9	1817.2
Medical speciality												
CD	4309	42.9	26.8	32.6	3.7	19.3	1584.7	69.0	112.2	3.7	27.6	1806.5
OM	2133	21.2	40.1	35.1	3.7	23	327.8	133.2	113.2	8.3	101.3	1146.2
OMS	2566	25.6	34.0	26.9	3.7	23.9	248.6	81.2	116.5	3.7	41.4	2109.1
IKM	432	4.3	18.7	5.1	7.4	18.4	37.8	121.0	169.6	7.4	64.4	1817.2
AMM	356	3.5	20.1	5.1	7.4	20.3	39.6	128.5	156.4	9.2	67.2	954.4
OS	405	4.0	18.8	7.2	4.6	16.6	58.9	38.0	52.9	7.4	24.9	725.1

Continued

Table 2B Continued

Category	Patient Total N (10 041)	%	Expense per visit*				Expense per patient*						
			Mean	SD	Min	Max	Mean	SD	Min	Max			
Medical institution type													
TH Hospital	714	7.1	32.9	59.1	3.7	19.3	1584.7	115.8	199.8	7.4	53.0	1806.5	
Hospital	93	0.9	18.3	8.9	3.7	16.6	44.2	43.7	58.1	7.4	25.8	325.1	
Clinic	823	8.2	19.2	8.6	4.6	4.6	58.9	30.5	54.1	3.7	13.8	231.9	
DM hospital	1669	16.6	43.9	37.8	3.7	16.6	327.8	42.6	67.2	8.3	23.9	725.1	
DM clinic	6656	66.3	29.6	24.2	3.7	27.6	198	128.7	126.0	4.6	93.9	1146.2	
KM hospital	70	0.7	28.5	10.8	7.4	22.1	102.2	74.0	96.7	3.7	36.0	2109.1	
KM clinic	757	7.5	19.3	5.1	7.4	29.5	38.7	135.0	142.7	7.4	92.6	974.3	
Others	30	0.3	8.6	5.5	3.7	18.4	22.1	123.7	161.3	7.4	65.3	1817.2	

\*Amount presented in US\$. 1 US\$=1086 KRW (average rate in December 2017).

†Others, national free medical treatment or veteran healthcare.

‡Surgery was counted as 'once' if a patient had been performed at least one surgery.

AMM, acupuncture and moxibustion medicine; CD, conservative dentistry; DM, dental medicine; GH, general hospital; IKM, internal Korean medicine; IP, inpatient; KM, Korean medicine; LCH, long-term care hospital; MD, medicaid; NHI, national health insurance; OM, oral medicine; OMS, oral and maxillofacial surgery; OP, outpatient; OS, orthopaedic surgery; PHC, public health centre; TH, tertiary hospital; WM, western medicine.

the majority of Western and dental medicine expenses, at 66.9% and 41.3% of all medical expenditures, respectively, while injection/non-surgical intervention fees accounted for the majority (54.7%) of Korean medicine expenses. Hospitalisation, anaesthesia, and medication accounted for the lowest percentages of medical expenditure.

While results for outpatients were only slightly different from those for all patients, inpatient results showed that injection/non-surgical intervention fees accounted for the greatest percentage (27.9%) of costs. In Western medicine inpatients, consultation fees accounted for the vast majority of the medical expenditure (90.6%). In Korean medicine inpatient care, hospitalisation fees accounted for 51.3% of total expenditures, which differed from inpatient care expenditures in Western medicine or dentistry, where the percentage spent on hospitalisation fees was very low or negligible.

### Usual care of TMD

The frequencies of claims for treatments according to usual care practice classifications in both outpatients and inpatients are shown in table 4. The most frequently performed treatment in outpatient care was TMJ stimulation (n=18 616, 51.1%). In Western medicine outpatient care, superficial heat therapy and subcutaneous or intramuscular injection were the most common forms of physiotherapy (n=511, 30.7%) and injection/non-surgical practices (n=184, 64.8%), respectively. There were no claim codes for surgery in Western medicine outpatient care. In dental outpatient care, TMJ stimulation (n=18 616, 85.1%) and occlusal adjustment (n=71, 55.5%) were the most frequently performed physiotherapy and injection/non-surgical interventions, respectively. The only surgery code claimed in outpatient dental care was TMJ arthrocentesis (n=45). Finally, general acupuncture (n=7228, 58.4%) was the most frequently performed intervention in Korean medicine outpatient care.

Among all inpatient claims, the most frequently performed treatment was continuous intravenous injection (n=55, 73.3%). In Western medicine inpatient care, bolus intravenous injection was performed only once. In dental inpatient care, physiotherapy was not performed, while continuous intravenous injection was the most frequently performed injection/non-surgical intervention. The only surgical code claimed in dental inpatient care was TMJ arthrocentesis (n=8). Finally, acupuncture was performed four out of six times in Korean medicine inpatient care.

### Medication prescribed for temporomandibular joint disorder

Table 5 lists the number of days of prescription by TMD drug according to the MOHW classification. The most common prescriptions in overall care and in dental outpatient care were psychosomatic drugs (86.4%). Antipyretic analgesic agents accounted for 50.9% of all Western medicine prescriptions. In dental inpatient care, oxygen was the most commonly prescribed (26.6%).


**Table 3** Distribution of medical expenditures for temporomandibular joint disorder according to medical practice type

Classification	Total			Western medicine			Dental medicine			Korean medicine		
	Count+	%	Cost*	Count†	%	Cost*	Count†	%	Cost*	Count†	%	Cost*
Outpatient visit (consultation)	30 406	35.4	275 662.3	2036	40.6	18 702.0	23 963	38.2	224 057.3	4407	24.2	32 903.0
OP	30 348	35.5	275 111.8	2031	40.6	18 576.4	23 911	38.3	223 644.2	4406	88.1	32 891.2
IP	58	13.8	550.5	5	50.0	125.7	52	13.1	413.0	1	8.3	11.8
Hospitalisation	25	0.0	555.5	0.1	-	-	22	0.0	506.7	3	0.0	48.7
OP	-	-	-	-	-	-	-	-	-	-	-	-
IP	25	6.0	555.5	13.3	0.0	-	22	5.5	506.7	3	25.0	48.7
Medication	1679	2.0	526.6	0.1	1.0	9.9	1056	1.7	163.1	569	3.1	352.4
OP	1635	1.9	417.5	0.1	1.0	9.9	1012	1.6	54.0	569	11.4	352.4
IP	44	10.5	109.2	2.6	0.0	-	44	11.1	109.2	2.8	-	-
Injection	14 015	16.3	42 135.8	6.5	9.4	510.2	357	0.6	1318.1	13 189	72.6	40 307.6
OP	13 854	16.2	41 379.7	6.5	9.3	507.3	207	0.3	599.3	13 181	263.5	40 273.1
IP	161	38.3	756.1	18.1	30.0	2.9	150	37.7	718.7	8	66.7	34.5
Anaesthesia	256	0.3	2417.7	0.4	2.9	1593.5	102	0.2	789.0	11	0.1	35.2
OP	214	0.3	1688.7	0.3	2.9	1593.5	60	0.1	60.0	11	0.2	35.2
IP	42	10.0	729.0	17.4	-	-	42	10.6	729.0	18.5	-	-
Physiotherapy	2849	3.3	8245.4	1.3	1664	3180.8	1185	1.9	5064.7	0.9	-	-
OP	2849	3.3	8245.4	1.3	1664	3180.8	1185	1.9	5064.7	0.9	-	-
IP	-	-	-	-	-	-	-	-	-	-	-	-
Psychotherapy	-	-	-	-	-	-	-	-	-	-	-	-
OP	-	-	-	-	-	-	-	-	-	-	-	-
IP	-	-	-	-	-	-	-	-	-	-	-	-
Procedure/Surgery	17 648	20.5	101 374.8	15.7	24	147.9	17 624	28.1	101 226.9	18.7	-	-
OP	17 612	20.6	100 206.9	15.7	24	147.9	17 588	28.2	100 059.0	18.6	-	-
IP	36	8.6	1167.9	27.9	-	-	36	9.0	1167.9	29.6	-	-
Examination	3548	4.1	81 657.5	12.7	75	162.5	3473	5.5	81 495.0	15.0	-	-
OP	3500	4.1	81 370.4	12.7	75	162.5	3425	5.5	81 207.8	15.1	-	-
IP	48	11.4	287.1	6.9	-	-	48	12.1	287.1	7.3	-	-
Radiographic evaluation/intervention	15 550	18.1	131 291.6	20.4	550	3659.1	15 000	23.9	127 632.5	23.5	-	-
OP	15 544	18.2	131 267.0	20.5	548	3649.0	14 996	24.0	127 618.0	23.7	-	-
IP	6	1.4	24.6	0.6	2	10.1	4	1.0	14.6	0.4	-	-
Total	85 976	100	643 867.2	100	5013	27 965.8	62 782	100	542 253.3	100	18 179	73 646.9
OP	85 556	100	639 687.3	100	5003	27 827.2	62 384	100	538 307.0	100	5003	73 551.9
IP	420	100	4179.9	100	10	138.6	398	100	3946.2	100	12	95.1

Missing values for medical specification and cost are excluded.

\*Cost amount presented in US\$. †US\$=1086 KRW (average rate in December 2017). For inpatients, costs of infection prevention management, consultation, medicine management, and the medical quality evaluation subsidy are aggregated. For outpatients, the medical quality evaluation subsidy is included in the outpatient visit (consultation) cost.

†Count means the number of claims.

‡Emergency patient was charged an emergency fee instead of an admission fee in the billing system.

IP, inpatient; OP, outpatient.



**Table 4** Usual care of patients with temporomandibular joint disorder

**Outpatient total (items 1, 2 and 3)**

Classification	Treatment	Code name	Count (n)	%
All usual care practices	TMJ stimulation	U2381, U2382, U2383	18 616	51.1
	Acupuncture	40011, 40012, 40030, 40050, 40060, 40070, 40080, 40 120	7228	19.9
	Hot and cold meridian therapy	40700, 40701, 40 702	2093	5.7
	Spray and stretch therapy	MX032	1986	5.5
	Cupping	10312, 40313, 40321, 40322, 40 323	1181	3.2
	Electroacupuncture	40 091	1103	3.0
	Moxibustion	40304, 40305, 40306, 40 307	781	2.1
	Superficial heat therapy	MM010, MM015	686	1.9
	Manipulation therapy	MX036	642	1.8
	Deep heat therapy	MM020	597.5	1.6
	Others*	MM070, MM085, KK010, MM080, MM300, MM101, U2290, LA341, LA232, UX044, U4900, N0771, KK090, MM090, MM030, MM011, KK061, KK062, MX121, KK020, KK052, C8020, U2352, MM131, U4830	1495	4.1
	Total			36 408.5
<b>(1) Western medicine outpatient</b>				
Physiotherapy	Superficial heat therapy	MM015	511	30.7
	Deep heat therapy	MM020	415	24.9
	Laser therapy	MM085	266	16.0
	TENS	MM070	265	15.9
	ICT	MM080	86	5.2
	Infrared ray irradiation	MM300	73	4.4
	Simple therapeutic exercise	MM101	16	1.0
	Massage therapy	MM090	15	0.9
	UV ray irradiation	MM030	8	0.5
	Cold therapy-cold pack	MM011	6	0.4
	Others	MX121, MM131, KK010, LA341, LA232, U4900, N0771, KK090, KK061, KK062, KK020, KK052	5	0.3
	Total			1666
Injection and non-surgical intervention	SC or IM injection	KK010	184	64.8
	Cranial nerve or its peripheral branch block	LA341, LA232	54.5	19.2
	Closed reduction of TMJ dislocation	U4900, N0771	18	6.3
	Intraarticular injection	KK090	15	5.3
	Perineural injection	KK061	4.5	1.6
	Others	KK062, KK020, KK052	8	2.8
	Total			284
<b>(2) Dental medicine outpatient</b>				
Physiotherapy	TMJ stimulation	U2381, U2382, U2383	18 616	85.1
	Spray and stretch therapy	MX032	1986	9.1

Continued

Table 4 Continued

**Outpatient total (items 1, 2 and 3)**

Classification	Treatment	Code name	Count (n)	%
	Manipulation therapy	MX036	642	2.9
	Deep heat therapy	MM020	182.5	0.8
	Superficial heat therapy	MM015	156.5	0.7
	TENS	MM070	134	0.6
	Simple therapeutic exercise	MM101	81	0.4
	Laser therapy	MM085	38	0.2
	Infrared ray irradiation	MM300	27	0.1
	ICT	MM080	9	0.0
	Total		21 872	100
Injection and non-surgical intervention	Occlusal adjustment	U2290	71	55.5
	Closed reduction of TMJ dislocation	U4900, N0771	22	17.2
	Intraarticular injection	KK090	15	11.7
	SC or intravenous injection	KK010	13	10.2
	Continuous intravenous injection	KK052	2	1.6
	Others	C8020, KK020, LA341, U2352, U4830, UX044	5	3.9
	Total		128	100
Surgery	TMJ arthrocentesis	UX044	45	100
	Total		45	100
<b>(3) Korean medicine outpatient</b>				
Acupuncture	Acupuncture	40011, 40012, 40030, 40050, 40060, 40070, 40080, 40 120	7228	58.4
	Electroacupuncture	40 091	1103	8.9
Physiotherapy	Hot and cold meridian therapy	40700, 40701, 40 702	2093	16.9
Moxibustion	Moxibustion	40304, 40305, 40306, 40 307	781	6.3
Cupping	Cupping	10312, 40313, 40321, 40322, 40 323	1181	9.5
	Total		12 386	100
<b>Inpatient (items 4, 5 and 6)</b>				
Classification	Treatment	Code name	Count (n)	%
Physiotherapy, injection and non-surgical intervention, surgery, acupuncture, moxibustion, cupping	Continuous intravenous injection	KK051, KK052, KK053, KK054	55	73.3
	TMJ arthrocentesis	UX044	8	10.7
	Acupuncture	40 012 to 40 080	4	5.3
	IV injection	KK020	3	4.0
	SC or intravenous injection	KK010	2	2.7
	Intraarticular injection	KK090	1	1.3
	Electroacupuncture	40 091	1	1.3
	Hot and cold meridian therapy	40 701	1	1.3
Total		75	100	
<b>(4) Western medicine inpatient</b>				
Injection and non-surgical intervention	IV injection	KK020	1	100
	Total		1	100
<b>(5) Dental medicine inpatient</b>				

Continued

Table 4 Continued

**Outpatient total (items 1, 2 and 3)**

Classification	Treatment	Code name	Count (n)	%
Injection and non-surgical intervention	Continuous intravenous injection	KK051, KK052, KK053, KK054	55	91.7
	SC or intravenous injection	KK010	2	3.3
	IV injection	KK020	2	3.3
	Intraarticular injection	KK090	1	1.7
	Total		60	100
Surgery	TMJ arthrocentesis	UX044	8	100
	Total		8	100
(6) Korean medicine inpatient				
Acupuncture	Acupuncture	40 012 to 40 080	4	66.7
	Electroacupuncture	40 091	1	16.7
Physiotherapy	Hot and cold meridian therapy	40 701	1	16.7
	Total		6	100

ICT, interferential current therapy; IM, intramuscular; SC, subcutaneous; TENS, transcutaneous electrical nerve stimulation; TMJ, temporomandibular joint.

Online supplemental table 1 shows the analysis of ATC codes specifically used within the top 10 MOHW classification categories. The most frequently used ATC codes among psychosomatic, radiopharmaceutical and antipyretic analgesic drugs in dental outpatient care were diazepam, technetium (99mTc) pertechnetate and paracetamol (acetaminophen), respectively. In Western medicine outpatient care, antipyretic analgesic agents were the most frequently used drug class, but the most frequently used ATC code was diazepam (n=117.5) among psychosomatic drugs, and tramadol (n=94) among antipyretic analgesic agents.

## DISCUSSION

In this cross-sectional, descriptive study, a total of 10 041 patients received care for TMD as the main diagnosis (K076 and S034). The number of patients, total cost, per-patient cost, per-claim cost, average days in care and average days of visit were all higher with the code K076 (2.4) than with the code S034 (2.1). As shown in online supplemental table 2, the average number of visits of 2.4 was the result reflecting the maximum number of visits of >100. Therefore, most patients visited once a year, while some patients visited more than 100 times.

TMD patients were more likely to be women, to be aged between 20 and 29 years, and to receive outpatient care. Among outpatients, TMJ stimulation and general acupuncture were the most frequently performed treatments, and psychosomatic drugs were the most frequently prescribed medications for TMD. Finally, consultation fees accounted for the greatest percentage of expenses for dental and Western medicine, while injection/non-surgical intervention fees accounted for the greatest percentage of expenses for Korean medicine. With 98%

of the Korean population enrolled in the NHI system, its claims data can be considered as nationally representative. This study is the first to analyse medical costs and usual care for TMD in Korea using the 2017 HIRA–NPS health insurance claims data.

A prior study reported that the preferred response to TMD is conservative treatment,<sup>23</sup> but the specific computation of the frequency of each treatment modality was lacking. Furthermore, in a special healthcare environment such as Korea, where Korean medical care is commonly used, analysing healthcare utilisation pertaining to TMD—which falls under dental, Western and Korean medicine—would add to the significance of the study.

In this study, we analysed the treatments most frequently used by clinicians for each TMD-related disease. These findings are useful in providing evidence for usual care and establishing treatment guidelines. We analysed the 2017 HIRA claims data for patients who received care for TMD in 2017, and we examined the status for codes K076 and S034 separately. Outpatient care accounted for the majority of both diagnostic codes, presumably because TMD patients generally have mild conditions with no mobility restrictions and their treatment is mostly non-surgical. At 0.7%, the percentage of patients who had surgery for TMD over the 1-year period observed in this study was also very low. The code K076 was more common, and we speculate that the K (disease) code was more common than the S (injury) code, as TMD is not an acute or fatal disease but rather a chronic condition that varies over time.<sup>9</sup>

Regarding the age of TMD patients, the highest percentage of patients were in their 20s for both the number of patients and the number of claims. The result showing that the prevalence of TMD decreases with age

**Table 5** Multifrequency medication use for temporomandibular joint disorder in the classification of medication by the Ministry of Health and Welfare, Korea

OP	WM OP			DM OP			DM IP		
	N	%	Class	N	%	Class	N	%	Class
Psychosomatic agents	10 447.2	86.4	Antipyretic analgesic agents	250.5	50.9	Psychosomatic agents	10 316.2	89.0	Oxygen
Radio-pharmaceutical	594.9	4.9	Psychosomatic agents	131	26.6	Radio-pharmaceutical	594.92	5.1	Mainly acting on gram-positive, negative bacteria
Antipyretic analgesic agents	472.5	3.9	Adrenal hormones agents	28	5.7	Antipyretic analgesic agents	222	1.9	Peptic ulcer Solvent
Skeletal muscle relaxant	133	1.1	Antihistamines	26.3	5.3	Skeletal muscle relaxant	126	1.1	Antipyretic analgesic agents
Adrenal hormones agents	129	1.1	Peptic ulcer Solvent	15	3.0	Antacid	126	1.1	Enzyme preparation
Antacid	129	1.1	Medications for organs of other tissue cells	9	1.8	Adrenal hormones agents	101	0.9	General anaesthetic
Local anaesthetics	63.4	0.5	Blood substitute	9	1.8	Local anaesthetics	56.1	0.5	Blood substitute
Peptic ulcer solvent	30	0.2	Local anaesthetics	7.3	1.5	Blood substitute	15	0.1	Adrenal hormones agents
Antihistamines	26.3	0.2	Skeletal muscle relaxant	7	1.4	Peptic ulcer solvent	15	0.1	Antitussive expectorants
Blood substitute	24	0.2	Enzyme preparation	3	0.6	Opium alkaloids	10	0.1	Opium alkaloids
Others	37.5	0.3	Others	5.9	1.2	Others	12.6	0.1	Others
Total	12 086.7	100	Total	491.9	100	Total	11 594.8	100	Total

\*There were only two prescriptions of antipyretic analgesic agents (114) in WM IP class, so we omitted the column for convenience. DM, dental medicine; IP, inpatient; KM, Korean medicine; OP, outpatient; WM, Western medicine.

is in line with a previous finding.<sup>24</sup> However, it is worth noting that the average number of days in care was higher among patients aged  $\geq 50$  years than among their younger counterparts. The exact reason for the higher incidence of TMD among women is unclear; however, some studies suggest that it is related to hormones.<sup>25–27</sup> One study reported an elevated oestrogen level in TMD patients,<sup>28</sup> however, no study has empirically identified a relationship between hormones and TMD.

In Korea, the healthcare system is broadly classified into Korean and Western medicine, excluding dental medicine, and this study is the first to investigate the status of TMD care in Korea including Korean medicine care. Our results showed that as of 2017, dental care in Korea was more commonly sought than Western or Korean medicine care for TMD treatment. This is consistent with previous results using the HIRA data set from 2003 to 2005.<sup>14</sup> After excluding dental medicine outpatients, Western and Korean medicine outpatients accounted for 9.8% and 8.2% of patients, respectively, and in terms of total visit count, Korean medicine outpatient visits accounted for the second highest percentage of visits following dental medicine outpatient visits.

Consultation fees accounted for the greatest percentage in both frequency and expense. Consultation is the most basic and frequently provided healthcare service. In a study that examined the status of cervical disorders using the HIRA–NPS data set, consultation fees accounted for the greatest percentage of medical cost.<sup>22</sup> Radiographic evaluation and intervention fees were the second highest in frequency and cost, showing that diagnostic testing is important in the care of TMD patients. When we compared dental and Western medicine only, there were more claims in dental medicine. In Western medicine, most claims were for physiotherapy; however, there were more expenses for treatment and surgery in dentistry. Whereas the frequency of treatment (and surgery fee claims) was 24 (147.9 US\$) in Western medicine, it was 17 624 (101 226.9 US\$) in dental medicine, suggesting that most surgical treatments were performed in dentistry. Further, because Korean medicine doctors currently face restrictions in using diagnostic devices, there were no claims for radiographic evaluation and intervention in Korean medicine. Due to the nature of Korean medicine care, fees for treatment and surgery and those for physiotherapy were also excluded in Korean medicine claims. Because acupuncture and cupping therapy fees are generally claimed in Korean medicine, claims for injection and non-surgical intervention accounted for the majority of covered benefits in Korean medicine (in both frequency and total cost).

As TMD patients are seldom hospitalised and rarely undergo surgery, hospitalisation and anaesthesia fees accounted for only a small proportion of medical expenditures. Medication fees also accounted for a small proportion, which shows that pharmacological treatment is relatively rare for TMD patients.

We examined the usual care that was mostly performed on TMD patients by dividing the sample into recipients of

outpatient and inpatient care. TMJ stimulation in dental medicine was the most frequently performed outpatient care (51.1%), and this can be considered the most basic care for TMD. TMJ stimulation refers to various treatments performed to treat TMD, and it encompasses a wide category of treatments such as superficial heat therapy, deep heat therapy, transcutaneous electrical nerve stimulation, low-frequency stimulation, myomonitor, silver spike point therapy, TMD exercise therapy, rehabilitative low-level laser therapy and myofascial trigger point injection. Because the same code can be used for different treatments and the same treatment can be classified into various codes, it can be difficult to assess physiotherapies by categorising them by their treatment codes. To examine the current state in more detail, treatment codes need to be revised. Superficial heat, deep heat and rehabilitative low-level laser therapies that have been frequently performed in Western medicine outpatient care can also be construed as physiotherapies overlapping with TMJ stimulation.

The second-most frequently performed treatment in outpatient care was general acupuncture (19.9%), which is only performed in Korean medicine. It is also the most commonly performed treatment in both inpatient and outpatient Korean medicine care. This shows that acupuncture therapy is the major treatment for TMD among covered Korean medicine care, and evidence for using acupuncture for TMD has been confirmed by multiple randomised controlled trials.<sup>29–31</sup> Surgery was only performed in dental medicine, and the rates of surgery were 0.12% and 10.7% in all outpatient and inpatient care, respectively, showing conservative treatment as the usual care for TMD patients, and that the surgery rate was higher among inpatients than among outpatients. According to our results, TMJ arthrocentesis was the only surgery code claimed in 2017. It seems to have been commonly performed on TMD patients in need of surgical treatment, as it is a relatively simple technique that can be performed as an alternative to a more invasive surgery.<sup>32</sup> Blocking of the cranial nerve or its peripheral branch in Western medicine outpatient care was the most often performed injection/non-surgical intervention. Many studies have reported that the tenderness of the masticatory muscles is the most consistent symptom related to TMD discovered during examination,<sup>33–36</sup> which is why subcutaneous or intramuscular injections are frequently administered. Blocking of the cranial nerve or its peripheral branch was rarely performed in dental medicine, suggesting that it is generally performed in Western medicine as opposed to in dentistry. Occlusal adjustment was the most common procedure in dentistry. Hot and cold meridian therapy was the second most common, as it is often combined with acupuncture therapy as a type of Korean medicine physiotherapy.

Drugs most often prescribed for TMD in outpatient care were psychosomatic drugs (86.4%), followed by radio-pharmaceuticals and antipyretic analgesic agents. Systematic reviews suggest that non-steroidal anti-inflammatory





drugs, acetaminophen, diazepam, hyaluronate, glucocorticoid, tricyclic antidepressants (TCAs) and anti-epileptic drugs may be effective for treating TMD pain. However, studies specifically comparing the effects of these drugs on TMD are limited, and adequate guidelines for pharmacotherapy are lacking.<sup>37 38</sup> In the only study that investigated the state of medications for TMD by drug group in Korea,<sup>14</sup> the most often prescribed drugs for outpatients from 2003 to 2005 were antipyretic analgesic agents (54.9%), psychosomatic drugs (20.4%) and skeletal muscle relaxants (17.5%). Although the order of frequency in that study differs from our findings, we observed that analgesics and psychosomatic drugs were generally used in the usual care of TMD.

According to our results, psychosomatic drugs were most frequently used in 2017, and diazepam was particularly most frequently prescribed. Diazepam is most widely used for anxiety disorders but is also known to be effective on muscle spasms.<sup>39</sup> Although the reason for its efficacy in TMD treatment has yet to be determined, it may be due to alleviation of underlying anxiety and spasm of muscles during mastication.<sup>40</sup> The TCA amitriptyline, the second-most frequently prescribed medication, is also known to be effective for muscle contraction and musculoskeletal pain.<sup>41</sup> Despite the efficacy of psychosomatic drugs, not many studies have recommended them as first-line medications for TMD, and further research is needed to substantiate their long-term effects and safety in TMD patients. The reason for such a change in trend is unknown, but it may suggest an association between TMD and psychiatric symptoms. Prior research has shown that chronic TMD is accompanied by psychiatric or mind-body diseases such as depression or somatisation disorder.<sup>42</sup> This is consistent with the findings of previous studies stating that comprehensive psychosocial intervention involving psychological treatment such as cognitive behavioural therapy, posture regulation and biofeedback produces better outcomes than do traditional dental care.<sup>43</sup>

The most frequent prescription among inpatients was oxygen, followed by antibiotics. Although there are no previous reports on the administration of these drugs in TMD patients, there is a possibility that these were administered due to an accompanying infectious disease or following a surgical procedure such as arthrocentesis. Although a prior study reported that antibiotics were administered to prevent infection after arthrocentesis,<sup>44</sup> it is difficult to conclude that antibiotic administration is related to surgery, as the number of days of antibiotic-related medication use was markedly lower in outpatients. Furthermore, this value is not an accurate representation of the administration of these medications, because there was only a small number of inpatients.

### Limitations

This study has several limitations. First, it may be difficult to accurately classify TMD using the diagnostic classifications for reimbursement. The HIRA–NPS includes data

submitted to receive compensation from the national payer only in areas where the purpose is covered by the NHI. Therefore, there may be a difference between the diagnosis submitted by medical service providers (doctors) for reimbursement and the actual diagnosis for the patient. This may be due to either under-reporting or coding of conditions that did not exist (ie, upcoding) in order to receive a large amount of doctor's fee under the Korean fee-for-service system. Because we operationally defined TMD in this study, defining TMD patient groups solely based on diagnosis would diminish the accuracy. However, because the diagnostic accuracy of the HIRA–NPS claims is on average about 70%,<sup>45</sup> it has little effect on our findings. Therefore, subsequent studies utilising claims data should pay close attention to diagnostic accuracy. It has been reported that diagnosis is more accurate for inpatients, severely ill patients and patients in general/tertiary hospitals than it is for outpatients, patients with frequently mild diseases and patients in clinics, respectively.<sup>45</sup> Furthermore, we used the data of patients who were assigned corresponding diagnostic codes. However, it is possible that the data set included patients who had been assigned an incorrect code or excluded patients due to misdiagnosis. Second, adherence to outpatient prescriptions was unknown, as there was no way to confirm whether the patients actually took the drugs. This is a limitation common to all claims data. Third, non-covered care and over-the-counter drugs were not included in claims data, as they are not claimed for payment. In this study, treatments such as intraoral occlusion appliance,<sup>46</sup> botulinum toxin injection<sup>47</sup> and pharmacopuncture,<sup>48</sup> among others, were not included. In particular, herbal medicine is generally prescribed as a non-covered prescription; thus, we were limited in our analysis on the drug prescriptions in Korean medicine. Furthermore, due to the limited number of inpatients included in the data set, detailed analysis of inpatient data was difficult. Therefore, our analysis is not representative of the entire patient population. Finally, this was a cross-sectional study analysing data over a 1-year period, so long-term follow-up was impossible. Future studies should use cohort claims data to additionally examine the natural course of the disease.

### CONCLUSIONS

This study analysed the current medical expenditures and usual care for TMD using the 2017 HIRA claims data. Our findings showed that patients with TMD visited the hospital visit 2.4 times a year and spent 29.7 US\$ per case as outpatients. Outpatient visit expenses accounted for the greatest proportion of all expenditures (35.4%), followed by treatment and surgery (20.5%), radiographic evaluation/intervention (18.1%) and injection/non-surgical intervention (16.3%). TMJ stimulation (51.1%) and acupuncture (19.9%) were most frequently performed in usual care practices, while psychosomatic drugs (86.4%) were the. The most commonly prescribed drugs in overall

care and in dental outpatient care. Considering the lack of research comparing patients with TMD in terms of Western medicine, dental medicine and medicine, dental medicine, Korean medicine, we believe our study is the first study to investigate the current status of TMD in Korea at the national level. We also believe our findings will provide useful information about the diversity of therapies for TMD and the corresponding costs incurred in the treatment of TMD. Our results regarding the distribution of medical costs for the treatment of relevant diseases can be used as evidence for making important health policy decisions such as the determination of health insurance fees and budgeting.

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**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** The study was approved by the Institutional Review Board of Jaseng Hospital of Korean Medicine in Seoul, Korea (JASENG 2019-05-007), and was performed in accordance with the principles expressed in the Declaration of Helsinki. Because the study analysed publicly available data, the need for informed consent was waived. All personal information was deidentified by the NHIS prior to public release.

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**Data availability statement** Data are available in a public, open access repository. Data are available upon reasonable request. The data sets generated during and/or analysed in the current study are available in the HIRA–NPS repository. The study utilised HIRA data, which are third-party data and thus not owned by the authors. The HIRA data are available upon direct request, via email or fax and submission of the request form and declaration of data use, which are downloadable from the HIRA website (<http://opendata.hira.or.kr/op/opc/selectPatDataApplInfoView.do>), and upon payment of a data request fee (300 000 KRW per data set).

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