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Seasonal variation in peripheral vestibular disorders based on Korean population data

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Abstract

Objectives: Comprehensive studies in which the seasonal variation in peripheral vestibular disorders was evaluated using data from an entire population are insufficient. The seasonal variation in peripheral vestibular disorders based on data from the entire Korean population was investigated in the present study.

Methods: Retrospective data from the National Health Insurance Service of Korea from 2008 to 2020 was analyzed. Benign paroxysmal positional vertigo (BPPV), vestibular neuritis (VN), and Meniere's disease (MD) were defined based on diagnostic, treatment, or audiovestibular test codes. The seasonal incidence for each peripheral vestibular disorder was calculated among all study subjects.

Results: For the entire study cohort, the incidence of BPPV was significantly higher in spring (odds ratio [OR] = 1.031, 95% confidence interval [CI] = 1.026–1.037), autumn (OR = 1.024, 95% CI = 1.019–1.029), and winter (OR = 1.051, 95% CI = 1.046–1.056) than in summer. The incidence of VN was significantly lower in winter (OR = 0.917, 95% CI = 0.907–0.927) than in summer. The incidence of MD was significantly higher in spring (OR = 1.027, 95% CI = 1.015–1.039) and autumn (OR = 1.029, 95% CI = 1.017–1.041) and significantly lower in winter (OR = 0.919, 95% CI = 0.908–0.931) than in summer. Differences were also observed in seasonal variation based on sex and age.

Conclusions: Significant seasonal variation occurred in peripheral vestibular disorders including BPPV, VN, and MD based on the entire Korean population data. Furthermore, seasonal variation showed differences based on sex and age.

Level of Evidence: 4.

KEYWORDS

benign paroxysmal positional vertigo, Meniere's disease, peripheral vestibular disorder, population-based study, season, seasonal variation, vestibular neuritis

1 | INTRODUCTION

The most common peripheral vestibular disorders are benign paroxysmal positional vertigo (BPPV), vestibular neuritis (VN), and Meniere's disease (MD).[1,2] BPPV is recurrent vertigo induced by positional change of the head.[3] VN is characterized by acute vertigo without hearing loss lasting for days to weeks.[4,5] MD has characteristics of vertigo, tinnitus, and sensorineural hearing loss with fluctuating symptoms and episodic attacks.[6]

Although BPPV is mostly idiopathic, vitamin D has recently been reported to be associated with BPPV, and serum vitamin D level was shown to vary seasonally.[3] The etiology of VN is unclear; however, a virus has been postulated as the etiology of VN.[4,5] Although the etiology of MD is also unclear, increase of endolymph within the inner ear membranous labyrinth (endolymphatic hydrops) is associated with the disease.[7]

There might be differences in the incidence of these diseases according to season in association with etiologies. There have been several studies about the seasonal variation in peripheral vestibular disorders.[1,3–6,8–17] Most studies about seasonal variation in peripheral vestibular disorders have focused on BPPV, followed by VN and MD. Seasonal variation in MD has been reported in only a few studies.[1] However, there are controversial reports on seasonal variation, and comprehensive evaluation of seasonal variation in peripheral vestibular disorders using data from an entire population is insufficient. Thus, further investigation based on data from an entire population is necessary.

We previously reported the incidence of peripheral vestibular disorders based on Korean population data, demonstrating that the annual incidence of BPPV, VN, and MD per 100,000 was 346.4, 62.9, and 50.5, respectively, in 2020 with increasing trends from 2008 through 2020.[2] Evaluation of seasonal variation in peripheral vestibular disorders can help identify the etiology of the disorders. As a subsequent study, seasonal variation in peripheral vestibular disorders was investigated based on data from the Korean population during a long period of 13 years in the present study.

2 | MATERIALS AND METHODS

2.1 | Subjects

Retrospective data from the National Health Insurance Service of Korea from 2008 to 2020 were used in the present study. All Korean people are required to join the National Health Insurance Service and almost all the people use medical services with the insurance coverage. Thus, results from this study are representative of the entire population of approximately 50 million. Peripheral vestibular disorders such as BPPV, VN, and MD were defined based on the diagnostic codes of the International Classification of Diseases (ICD), treatment code for canalith repositioning maneuver, audiometric test codes including pure tone audiometry, speech audiometry, auditory brainstem response, and auditory steady-state response, and vestibular function test codes including nystagmus test and caloric test. Patients were defined as patients with BPPV when they underwent canalith repositioning maneuver under the diagnostic code of BPPV (H81.1 in the ICD). Patients were defined as patients with VN when they underwent a vestibular function test once or more at admission or at the outpatient department with re-visit within 1 month under the diagnostic code of VN (H81.2 in the ICD). Patients who underwent both audiometric and vestibular function tests once or more at admission or at the outpatient department with re-visit within 1 month under the diagnostic code of MD (H81.0 in the ICD) were defined as patients with MD. Patients with new onset of peripheral vestibular disorders during the study period were included in the present study. Patients were grouped based on sex and age (20-year intervals). Patients were not classified according to outpatient or inpatient treatments because the comprehensive investigation of seasonal variation in peripheral vestibular disorders was the objective of this study.

The Institutional Review Board of the authors' institution approved this study (NHIMC 2022–01-029). Written informed consent was waived due to the retrospective nature of the study.

2.2 | Data analysis

The seasonal incidence for each peripheral vestibular disorder was calculated among all patients in the study cohort. Spring included March, April, and May; summer included June, July, and August; autumn included September, October, and November; and winter included December, January, and February. Logistic regression was used to analyze seasonal variation in peripheral vestibular disorders for the entire study cohort as well as differences in seasonal variation based on sex and age. Statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA).

3 | RESULTS

For the entire study cohort, the incidence of BPPV was significantly higher in spring (odds ratio [OR] = 1.031, 95% confidence interval [CI] = 1.026–1.037), autumn (OR = 1.024, 95% CI = 1.019–1.029), and winter (OR = 1.051, 95% CI = 1.046–1.056) than in summer. For males, the incidence of BPPV was significantly higher in winter (OR = 1.020, 95% CI = 1.011–1.030) than in summer. For females, the incidence of BPPV was significantly higher in spring (OR = 1.042, 95% CI = 1.035–1.048), autumn (OR = 1.033, 95% CI = 1.027–1.039), and winter (OR = 1.065, 95% CI = 1.059–1.071) than in summer.

For the entire study cohort, the incidence of VN was significantly lower in winter (OR = 0.917, 95% CI = 0.907–0.927) than in summer. For males, the incidence of VN was significantly lower in autumn (OR = 0.979, 95% CI = 0.962–0.996) and winter (OR = 0.888, 95% CI = 0.872–0.904) than in summer. For females, the incidence of VN was significantly higher in spring (OR = 1.023, 95% CI = 1.010–1.037) and autumn (OR = 1.021, 95% CI = 1.007–1.034) and significantly lower in winter (OR = 0.934, 95% CI = 0.922–0.947) than in summer.

For the entire study cohort, the incidence of MD was significantly higher in spring (OR = 1.027, 95% CI = 1.015–1.039) and autumn (OR = 1.029, 95% CI = 1.017–1.041) and significantly lower in winter (OR = 0.919, 95% CI = 0.908–0.931) than in summer. For males, the incidence of MD was significantly lower in winter (OR = 0.898, 95% CI = 0.878–0.919) than in summer. For females, the incidence of MD was significantly higher in spring (OR = 1.034, 95% CI = 1.020–1.049) and autumn (OR = 1.043, 95% CI = 1.028–1.057) and significantly lower in winter (OR = 0.928, 95% CI = 0.915–0.942) than in summer (Table 1).

For patients 0–19 years of age, the incidence of BPPV was significantly lower in spring (OR = 0.806, 95% CI = 0.777–0.837) and winter (OR = 0.780, 95% CI = 0.751–0.810) than in summer. For patients 20–39 years of age, the incidence of BPPV was significantly higher in autumn (OR = 1.045, 95% CI = 1.033–1.058) and significantly lower in spring (OR = 0.947, 95% CI = 0.936–0.959) and winter (OR = 0.971, 95% CI = 0.960–0.983) than in summer. For patients 40–59 years of age, the incidence of BPPV was significantly higher in spring (OR = 1.020, 95% CI = 1.012–1.028), autumn (OR = 1.036, 95% CI = 1.028–1.044), and winter (OR = 1.052, 95% CI = 1.044–1.060) than in summer. For patients ≥60 years of age, the incidence of BPPV was significantly higher in spring (OR = 1.105, 95% CI = 1.096–1.114) and winter (OR = 1.109, 95% CI = 1.100–1.118) than in summer.

For patients 0–19 years of age, the incidence of VN was significantly lower in spring (OR = 0.909, 95% CI = 0.847–0.976) and winter (OR = 0.747, 95% CI = 0.694–0.805) than in summer. For patients 20–39 years of age, the incidence of VN was significantly higher in autumn (OR = 1.072, 95% CI = 1.044–1.101) and significantly lower in winter (OR = 0.882, 95% CI = 0.858–0.907) than in summer. For patients 40–59 years of age, the incidence of VN was significantly higher in autumn (OR = 1.029, 95% CI = 1.013–1.046) and significantly lower in winter (OR = 0.945, 95% CI = 0.930–0.961) than in summer. For patients ≥60 years of age, the incidence of VN was significantly higher in spring (OR = 1.030, 95% CI = 1.013–1.047) and significantly lower in autumn (OR = 0.946, 95% CI = 0.931–0.962) and winter (OR = 0.917, 95% CI = 0.902–0.932) than in summer.

For patients 0–19 years of age, the incidence of MD was significantly lower in spring (OR = 0.879, 95% CI = 0.820–0.942) and winter (OR = 0.713, 95% CI = 0.662–0.767) than in summer. For patients 20–39 years of age, the incidence of MD was significantly higher in autumn (OR = 1.098, 95% CI = 1.068–1.129) and significantly lower in spring (OR = 0.964, 95% CI = 0.937–0.992) and winter (OR = 0.853, 95% CI = 0.828–0.878) than in summer. For patients 40–59 years of age, the incidence of MD was significantly higher in spring (OR = 1.040, 95% CI = 1.021–1.059) and autumn (OR = 1.038, 95% CI = 1.019–1.057) and significantly lower in winter (OR = 0.950, 95% CI = 0.932–0.968) than in summer. For patients ≥60 years of age, the incidence of MD was significantly higher in spring (OR = 1.061, 95% CI = 1.041–1.081) and significantly lower in winter (OR = 0.939, 95% CI = 0.921–0.957) than in summer (Table 2).

4 | DISCUSSION

The seasonal variation in BPPV has been investigated in several studies[9–14,16]; however, significant differences were not found based on month or season in our previous single-center study.[3] Seasonal

TABLE 1 Seasonal variation of peripheral vestibular disorders in total and according to sex.

		Total				Sex							
						Male				Female			
			95% CI				95% CI				95% CI		
		OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value
BPPV	Winter	1.051	1.046	1.056	<.0001*	1.020	1.011	1.030	<.0001*	1.065	1.059	1.071	<.0001*
	Autumn	1.024	1.019	1.029	<.0001*	1.005	0.996	1.014	.3035	1.033	1.027	1.039	<.0001*
	Spring	1.031	1.026	1.037	<.0001*	1.009	0.999	1.018	.0695	1.042	1.035	1.048	<.0001*
	Summer	1.000				1.000				1.000			
VN	Winter	0.917	0.907	0.927	<.0001*	0.888	0.872	0.904	<.0001*	0.934	0.922	0.947	<.0001*
	Autumn	1.005	0.995	1.016	.3313	0.979	0.962	0.996	.0143*	1.021	1.007	1.034	.0023*
	Spring	1.010	1.000	1.021	.0580	0.988	0.971	1.005	.1722	1.023	1.010	1.037	.0006*
	Summer	1.000				1.000				1.000			
MD	Winter	0.919	0.908	0.931	<.0001*	0.898	0.878	0.919	<.0001*	0.928	0.915	0.942	<.0001*
	Autumn	1.029	1.017	1.041	<.0001*	0.997	0.975	1.019	.7746	1.043	1.028	1.057	<.0001*
	Spring	1.027	1.015	1.039	<.0001*	1.010	0.988	1.032	.3912	1.034	1.020	1.049	<.0001*
	Summer	1.000				1.000				1.000			

Abbreviations: BPPV, benign paroxysmal positional vertigo; CI, confidence interval; MD, Meniere's disease; OR, odds ratio; VN, vestibular neuritis.
*p-value <.05.

TABLE 2 Seasonal variation of peripheral vestibular disorders according to age.

		Age (year)															
		0–19				20–39				40–59				≥60			
			95% CI				95% CI				95% CI				95% CI		
		OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value
BPPV	Winter	0.780	0.751	0.810	<.0001*	0.971	0.960	0.983	<.0001*	1.052	1.044	1.060	<.0001*	1.109	1.100	1.118	<.0001*
	Autumn	1.032	0.997	1.069	.0759	1.045	1.033	1.058	<.0001*	1.036	1.028	1.044	<.0001*	0.993	0.984	1.001	.0813
	Spring	0.806	0.777	0.837	<.0001*	0.947	0.936	0.959	<.0001*	1.020	1.012	1.028	<.0001*	1.105	1.096	1.114	<.0001*
	Summer	1.000				1.000				1.000				1.000			
VN	Winter	0.747	0.694	0.805	<.0001*	0.882	0.858	0.907	<.0001*	0.945	0.930	0.961	<.0001*	0.917	0.902	0.932	<.0001*
	Autumn	1.045	0.976	1.119	.2042	1.072	1.044	1.101	<.0001*	1.029	1.013	1.046	.0004*	0.946	0.931	0.962	<.0001*
	Spring	0.909	0.847	0.976	.0084*	0.992	0.965	1.019	.5424	1.011	0.995	1.028	.1842	1.030	1.013	1.047	.0004*
	Summer	1.000				1.000				1.000				1.000			
MD	Winter	0.713	0.662	0.767	<.0001*	0.853	0.828	0.878	<.0001*	0.950	0.932	0.968	<.0001*	0.939	0.921	0.957	<.0001*
	Autumn	1.016	0.950	1.087	.6451	1.098	1.068	1.129	<.0001*	1.038	1.019	1.057	<.0001*	0.982	0.963	1.001	.0617
	Spring	0.879	0.820	0.942	.0003*	0.964	0.937	0.992	.0131*	1.040	1.021	1.059	<.0001*	1.061	1.041	1.081	<.0001*
	Summer	1.000				1.000				1.000				1.000			

Abbreviations: BPPV, benign paroxysmal positional vertigo; CI, confidence interval; MD, Meniere's disease; OR, odds ratio; VN, vestibular neuritis.
*p-value <.05.

variation in BPPV was not observed in a population-based study in Germany.[1] However, in the present study, BPPV occurred significantly more frequently in spring, autumn, and winter than in summer, and winter showed the highest incidence. This result supports the association between vitamin D and BPPV. Regarding sex, seasonal influence on the incidence of BPPV was greater in females than in males. The greater seasonal variation in BPPV in females may be attributed to the more pronounced effect of vitamin D on BPPV, similar to other vitamin D and calcium-related diseases such as osteopenia and osteoporosis.

Regarding age, the risk of BPPV was significantly lower in spring and winter than in summer in patients 0–19 years and 20–39 years of age. The risk of BPPV in spring and winter increased with age compared with that in summer. The higher risk of BPPV in summer in young people could be due to their greater physical activity in summer than in other seasons, which could be associated with detachment of the otoconia from the utricular macula. Vitamin D seems to influence older individuals more than younger subjects.

The risk of VN was significantly lower in winter than in summer in the present study. In previous studies in the United States and Croatia, seasonal variation was not reported.[4,8] In addition, seasonal variation was not found in a population-based study in Germany.[1] In our previous single-center study, the incidence of VN was highest in summer and lowest in winter but without significant seasonal variation.[5] However, in contrast to these previous studies, the results of this population-based study showed seasonal variation in VN.

A virus has been suggested as the etiology of VN because patients with VN had a viral prodrome and VN typically occurred in spring and early summer.[5] The focus was on the association between upper respiratory viral infection and VN. However, latent viral infection should be considered in the pathogenesis of VN. Latent viral infection, vascular ischemia, and autoimmune reaction have been proposed as etiologies of VN. Reactivation of latent herpes simplex virus type 1 could be associated with VN.[5] Reactivation of latent viral infection might be associated with seasonal variation. Exposure to ultraviolet radiation has been known to trigger herpes simplex virus reactivation. In a prospective population-based cohort study in Sweden, reactivation of latent herpes infection was two times higher in summer than in winter and was associated with higher ultraviolet radiation.[18] Thus, multiple etiologies of VN, including reactivation of latent viral infection and vascular ischemia, should be considered in the analysis of incidence.[5]

In males, the risk of VN was lower in autumn and winter than in summer. Conversely, in females, the risk of VN was lower in winter than in summer but higher in spring and autumn than in summer. This difference might be due to different etiologic factors of VN due to sex; however, further investigation is necessary. For all ages, the risk of VN was lower in winter than in summer. However, the risk of VN in winter compared with summer was lower in patients ≤39 years of age than in subjects ≥40 years of age. Other causes such as vascular ischemia, which might not have seasonal variation, could influence the incidence in older patients.

The risk of MD was lower in winter than in summer and higher in spring and autumn than in summer. Although the risk was lower in winter than in summer in both males and females, difference in other seasons were observed based on sex. Based on age, the risk of MD was lower in winter than in summer for all ages. However, the risk of MD was higher in spring than in summer in patients 40–59 years and ≥ 60 years of age, whereas the risk of MD was lower in spring than in summer in patients 0–19 and 20–39 years of age. In a previous study based on similar Korean population data from 2013 through 2017 the incidence of MD was relatively high in summer and autumn and relatively low in winter and spring, without significant difference.[6] In contrast, there was no significant difference in the distribution of Meniere's disease among seasons using similar Korean population data from 2008 through 2015.[15] The seasonal variation in MD observed in the present study was based on a more recent and longer period of data and included the entire population.

The seasonal variation of MD may be attributed to meteorological factors. The temperature and humidity are highest and atmospheric pressure the lowest in summer in Korea.[6] High humidity and lower atmospheric pressure were reportedly associated with vertigo attack, tinnitus, and ear fullness.[6,19] A change in atmospheric pressure may affect endolymphatic hydrops through the middle ear.[6,17,19] Sound speed increases when the air is humid, and the effect of humidity is slightly greater at lower atmospheric pressure.[6] In addition, more frequent physical activity and subsequent fatigue in spring, summer, and autumn than in winter could induce symptoms of MD, especially in males and young patients.

The results of the present study in which data from the entire Korean population were used showed significant seasonal variation in BPPV, VN, and MD. However, the ORs were low, indicating minimal significant differences. Differences in seasonal variation based on sex and age were observed in the same disease. These results suggest that multiple etiologic factors could be associated with BPPV, VN, and MD, and the influence of these factors could differ based on sex and age.

The present study had several limitations. First, the seasonal variation in peripheral vestibular disorders was analyzed using diagnostic, audiovestibular test, and treatment codes. Thus, actual patients might not be represented. Second, age was divided into 20-year intervals and other confounding factors that might affect seasonal variation were not considered. However, seasonal variation in major peripheral vestibular disorders was verified using data from the Korean population during a long period in this study.

5 | CONCLUSION

Significant seasonal variation was observed in peripheral vestibular disorders including BPPV, VN, and MD based on data from the entire Korean population. The seasonal variation differed based on sex and age.

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CONFLICT OF INTEREST STATEMENT

The authors declare no potential conflict of interest.

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