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Comparison of The Salty Taste Test Results, The Olfactory Test Results, and Questionnaire Survey Results before the COVID-19 Epidemic (2019) and after the COVID-19 Epidemic (2022) in The Medical Examination for Residents of Yakumo Town, Hokkaido, Japan in the Same 100 Participants

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Abstract

Since 2005, we have conducted a questionnaire survey on taste and olfaction, the salty taste test, and the olfactory test in Yakumo Town, Hokkaido, Japan. However, due to the COVID-19 epidemic, resident screening was canceled in 2020 and 2021. We investigated the potential impact of COVID-19 by comparing results from the salty taste test, olfactory tests, and questionnaire surveys. Data were analyzed for a total of 100 individuals, 42 males, and 58 females, who underwent screening in both 2019 and 2022. The questionnaire survey included items regarding the subjective presence or absence of dizziness, tinnitus, headache, taste, smell, and saliva secretion.

Furthermore, we obtained results from a salty taste test using the Solsave kit (manufactured by Advantech) and olfactory test results using the smell stick kit (manufactured by Daiichi Kogyo Co., Ltd.). Consequently, when comparing the results of the olfactory test between 2019 and 2022 for 42 males, a statistically significant difference ($p = 0.004$) emerged. The ability to understand odors was more challenging in 2022 compared to 2019. Specifically, distinguishing between the odors of perfume ($p = 0.044$), menthol ($p = 0.032$), mandarin orange ($p = 0.032$), and fried garlic ($p = 0.019$) proved to be difficult.

Similarly, in the comparison of 2019 and 2022 for 58 females, there was a statistically significant difference ($p = 0.033$) in olfactory test results, indicating that comprehending odors was more difficult in 2022 than in 2019. Particularly, distinguishing between the odors of perfume ($p = 0.026$), mandarin orange ($p = 0.026$), and condensed milk ($p = 0.018$) presented challenges. There was no statistically significant difference in the results of the salty taste test and questionnaire survey for both males and females. To determine whether the observed changes in olfactory sense are due to aging changes over the three years or the effects of COVID-19, ongoing investigation is crucial. It is necessary to continue assessing whether this diminished sense of smell will recover in the future.

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Original Article

Keywords

Yakumo Study, Taste Test, Olfactory Test, Questionnaire Survey, COVID-19

Introduction

Since 2005, we have continued to conduct surveys using questionnaires, the salty taste test kit, and the olfactory test kit at the Yakumo Town residents' medical examination in Hokkaido, Japan. We have previously reported that the sensitivity threshold for salty taste is preserved with age, but that the sense of smell declines with age [1-5]. We also reported that men's sense of smell declines faster than women's [1-5]. Other researchers have reported a decline in the sense of smell and taste as an early symptom of Alzheimer's dementia [6]. Additionally, other researchers have reported that having COVID-19 affects one's sense of smell and taste [7-16]. This time, we decided to compare the data of the same participants in the health checkup for residents of Yakumo Town, Hokkaido, Japan, which we have been conducting for many years, to examine whether the sense of taste and smell changed before and after the COVID-19 epidemic.

Material and Method

Using the salty taste test kit (Solsave: manufactured by Advantech Co., Ltd.), the taste was measured by holding filter paper impregnated with 0.6%, 0.8%, 1.0%, 1.2%, 1.4%, and 1.6% salty taste in the mouth and feeling the salty taste. % was recorded as the result.

Using the olfactory test kit (smell stick: Daiichi Kogyo Co., Ltd.), 12 types of olfaction (ink, lumber, perfume, menthol, mandarin orange, curry, household gas, rose, cypress, stuffy socks, sweat, etc.) were tested. (smell of milk, condensed milk, sautéed garlic) was rubbed with a finger on an oiled filter paper, each of which was confined in minute capsules.

The questionnaire survey included self-reported responses regarding subjective dizziness (1. Never, 2. Occasionally, 3. Often) and subjective tinnitus (1. Never, 2. Occasionally, 3. Always). Participants were also asked about the subjective presence or absence of headaches (1. No, 2. Yes) and their subjective sense of smell (1. Not at all, 2. Slightly, 3. Sometimes difficult to understand, 4. Good). Furthermore, subjects were requested to indicate the status of their sense of taste (1. Not at all, 2. Slightly, 3. Sometimes difficult to understand, 4. Understandable) and the subjective level of saliva secretion (1. Often, 2. Normal, 3. Slightly). Refer to **Table-1** for details.

The results were processed statistically. An F-test was conducted to compare 2019 and 2022 for males and females, respectively. In cases where no significant difference was found in the F-test, the paired Student's t-test was employed. Conversely, when a significant difference was observed, the Wilcoxon test was used to confirm the presence or absence of statistical significance. Additionally, concerning the gender difference between 2019 and 2022, following the F-test, the unpaired Student's t-test was utilized if no significant difference was present. Alternatively, if a significant difference existed, the Mann-Whitney test was employed to perform the statistical analysis. The presence or absence of a significant difference was ascertained.

Table-1: Subjective Questionnaire Survey Results and Answer Options

	1	2	3	4
Vertigo	Do not have	Sometimes	Common	
Tinnitus	Do not have	Occasionally	Always	
Headache	Do not have	Have		
Sense of smell	Do not have	Slightly understand	Understand	Understand well
Sense of taste	Do not have	Slightly understand	Understand	Understand well
Salivation	Secrete well	Secrete	Slightly secrete	

Results

Out of the 100 participants, 42 were male, and 58 were female. The age distribution is displayed in **Table-2.1** for 2019 and **Table-2.2** for 2022. The majority of the participants were in their 60s, followed by individuals in their 70s.

Table-2.1: Age Distribution of 100 People who Participated in the Yakumo Residents' Medical Examination in 2019

	40s	50s	60s	70s	80s	Total
Male	4	10	12	15	1	42
Female	8	12	25	11	2	58
Total	12	22	37	26	3	100

Table-2.2: Age Distribution of 100 People who Participated in the Yakumo Residents' Medical Examination in 2022

	40s	50s	60s	70s	80s	Total
Male	1	7	15	17	2	42
Female	6	10	24	15	3	58
Total	7	17	39	32	5	100

Table-3.1: Subjective Questionnaire Survey Results (2019 and 2022) Males (n=42)

Question item	Inspection year	Choice number				
		1	2	3	4	No answer
Vertigo	2019	34	8	0	0	0
	2022	34	6	1	0	1
Tinnitus	2019	29	8	5	0	0
	2022	27	9	6	0	0
Headache	2019	42	0	0	0	0
	2022	39	3	0	0	0
Sense of smell	2019	1	1	9	31	0
	2022	0	0	12	30	0
Sense of taste	2019	0	0	6	36	0
	2022	0	0	7	35	0
Salivation	2019	15	26	1	0	0
	2022	17	25	0	0	0

Table-3.2: Subjective Questionnaire Survey Results (2019 and 2022) Females (n=58)

Question item	Inspection year	Choice number				
		1	2	3	4	No answer
Vertigo	2019	44	10	4	0	0
	2022	45	11	2	0	0
Tinnitus	2019	33	20	5	0	0
	2022	35	15	8	0	0
Headache	2019	50	8	0	0	0
	2022	52	6	0	0	0
Sense of smell	2019	0	3	12	43	0
	2022	1	2	8	47	0
Sense of taste	2019	0	0	6	52	0
	2022	0	1	1	54	2
Salivation	2019	9	47	2	0	0
	2022	10	47	1	0	0

The questionnaire survey results for males are presented in **Table-3.1**, while the results for females are shown in **Table-3.2**. The salty taste test results for males can be found in **Table-4.1**, and for females, they are presented in **Table-4.2**. Additionally, the olfactory test results for males are displayed in **Table-5.1**, and for females, they are shown in **Table-5.2** below.

In the results of the self-administered questionnaire survey, a statistical comparison was conducted between 2019 and 2022 (Male: **Table-6.1**, Female: **Table-6.2**). There was no significant difference observed for subjective dizziness, tinnitus, headache, taste, olfactory perception, and saliva secretion.

Table-4.1: Comparison of the Saltiness Test Results (2019 and 2022) Males (n=42)

	0.60%	0.80%	1.00%	1.20%	1.40%	1.60%	1.80%	Total
2019	16	10	6	2	2	1	5	42
2022	18	9	6	3	2	0	4	42
Total	34	19	12	5	4	1	9	84

Table-4.2: Comparison of the Saltiness Test Results (2019 and 2022), Females (n=58)

	0.60%	0.80%	1.00%	1.20%	1.40%	1.60%	1.80%	Total
2019	33	10	7	0	2	0	6	58
2022	29	12	8	2	4	1	2	58
Total	62	22	15	2	6	1	8	116

Table-5.1: Comparison of the Number of Correct Answers in the Odor Test (2019 and 2022) Males (n=42)

	India ink	Timber	Perfume	Menthol	Mandarin orange	Curry
2019	18	22	30	34	28	35
2022	16	20	21	25	23	29
	Household gas	**Rose**	**Cypress**	**Stink socks/ Sweat**	**Condensed milk**	**Fried garlic**
2019	22	15	23	33	29	37
2022	30	9	24	29	26	28

Table-5.2: Comparison of the Number of Correct Answers in the Odor Test (2019 and 2022) Females (n=58)

	India ink	Timber	Perfume	Menthol	Mandarin orange	Curry
2019	38	35	46	47	46	51
2022	33	34	35	38	35	48
	Household gas	**Rose**	**Cypress**	**Stink socks/ Sweat**	**Condensed milk**	**Fried garlic**
2019	40	29	37	49	49	48
2022	47	24	41	44	38	44

Table-6.1: Comparison of Questionnaire Survey Results of 42 Male in 2029 and 2022

	Subjective Dizziness		Subjective Tinnitus		Subjective Headache	
	2019	2022	2019	2022	2019	2022
Average value	1.19	1.195	1.429	1.5	1	1.071
Standard deviation	0.397	0.459	0.703	0.741	0	0.261
F test	P=0.177		P=0.369		-	
Paird t-test Wilcoxon	P=1.000		P=0.412		P=0.083	
	Subjective Taste		**Subjective Smell**		**Subjective Saliva**	
	2019	2022	2019	2022	2019	2022
Average value	3.857	3.833	3.667	3.714	1.667	1.595
Standard deviation	0.354	0.377	0.65	0.457	0.526	0.497
F test	P=0.342		P=0.012*		P=0.358	
Paird t-test Wilcoxon	P=0.66		P=0.779		P=0.323	

Table-6.2: Comparison of Questionnaire Survey of Questionnaire Survey Results of 58 Females in 2029 and 2022

	Subjective Dizziness		Subjective Tinnitus		Subjective Headache	
	2019	2022	2019	2022	2019	2022
Average value	1.31	1.259	1.517	1.534	1.138	1.103
Standard deviation	0.598	0.515	0.655	0.731	0.348	0.307
F test	P=0.128		P=0.205		P=0.173	
Paird t-test Wilcoxon	P=0.536		P=0.864		P=0.484	
	Subjective Taste		**Subjectibe Smell**		**Subjective Saliva**	
	2019	2022	2019	2022	2019	2022
Average value	3.897	3.946	3.69	3.741	1.879	1.845
Standard deviation	0.307	0.297	0.568	0.609	0.422	0.41
F test	P=0.396		P=0.302		P=0.416	
Paird t-test Wilcoxon	P=0.419		P=0.626		P=0.641	

Table-7: Comparison Results of 42 Males and 58 Females in 2029 and 2022

Male participant	**Saltiness Test**		**Olfactory Test**	
	2019	**2022**	**2019**	**2022**
Average value	0.925	0.795	7.951	6.643
Standard deviation	0.425	0.375	2.549	3.019
F test	P=0.212		P=0.14	
Paird t-test Wilcoxon	P=0.612		P=0.004**	
Female participant	**Saltiness Test**		**Olfactory Test**	
	2019	**2022**	**2019**	**2022**
Average value	0.834	0.831	8.845	8
Standard deviation	0.38	0.32	2.254	2.596
F test	P=0.094		P=0.143	
Paird t-test Wilcoxon	P=0.955		P=0.033*	

There were no significant differences in the results of the salty taste test (refer to **Table-7**). However, the olfactory test results exhibited a statistically significant disparity. Both males (p = 0.004) and females (p = 0.033) displayed notably less distinguishable olfactory test outcomes in 2022 as compared to 2019. It was observed that males had a higher level of obscurity compared to females.

Based on the aforementioned outcomes, the count of accurate responses for each odor in 2019 and 2022 is provided (male: **Table-8.1**, female: **Table-8.2**). The tally of correct answers for each odor in the olfactory test results was subjected to statistical comparison using the chi-square test (refer to **Table-9**).

Consequently, out of the 12 odor types, males exhibited a notable decline in the perception of perfume (p = 0.044), menthol (p = 0.032), mandarin orange (p = 0.032), and fried garlic (p = 0.019), with these odors being significantly less distinguishable in 2022 compared to 2019.

Among the 12 odors, females demonstrated an increased difficulty in discerning the scents of perfume (p = 0.026), mandarin orange (p = 0.026), and condensed milk (p = 0.018) in 2022 compared to 2019. Statistically, the ability to detect these smells became more challenging with age.

Furthermore, a statistical comparison was conducted between male and female odor test results for the same year. As a result, a significant difference between males and females was observed in 2019 for India ink (p = 0.024), indicating that males had more difficulty in perceiving the smell compared to females.

Table-8.1: Comparison of the Percentage of Correct Answers in the Odor Test (2019 and 2022) Males (n=42)

	India ink	Timber	Perfume	Menthol	Mandarin Orange	Curry
2019	42.86	52.38	71.43	80.95	66.67	83.33
2022	38.10	47.62	50.00	59.52	54.76	69.05
	Household Gas	**Rose**	**Cypress**	**Stink Socks/ Sweat**	**Condensed Milk**	**Fried Garlic**
2019	52.38	35.71	54.76	78.57	69.05	88.10
2022	71.43	21.43	57.14	69.05	61.90	66.67

Table-8.2: Comparison of the Percentage of Correct Answers in the Odor Test (2019 and 2022) Females (n=58)

	India ink	Timber	Perfume	Menthol	Mandarin Orange	Curry
2019	65.52	60.34	79.31	81.03	79.31	87.93
2022	63.46	65.38	67.31	73.08	67.31	92.31
	Household Gas	**Rose**	**Cypress**	**Stink Socks/ Sweat**	**Condensed Milk**	**Fried Garlic**
2019	68.97	50.00	63.79	84.48	84.48	82.76
2022	90.38	46.15	78.85	84.62	73.08	84.62

Table-9: Comparison of Correct and Incorrect Answers for each Odor in Olfactory Test Results (Chi-Square Test)

	Comparison of 42 males in 2019 and 2020	Comparison of 58 females in 2019 and 2020	Comparison of males and females in 2019	Comparison of males and females in 2020
Smell item	Chi-square test P value	Chi-square test P value	Chi-square test P value	Chi-square test P value
Indea ink	P=0.657	P=0.341	P=0.024*	P=0.063
Timber	P=0.663	P=0.850	P=0.427	P=0.276
Perfume	P=0.044 *	P=0.026*	P=0.362	P=0.304
Menthol	P=0.032*	P=0.059	P=0.992	P=0.540
Mandarin orenge	P=0.032*	P=0.026*	P=0.155	P=0.577
Curry	P=0.124	P=0.431	P=0.523	P=0.108
Household gas	P=0.072	P=0.133	P=0.092	P=0.260
Rose	P=0.147	P=0.351	P=0.155	P=0.036*
Cypress	P=0.826	P=0.429	P=0.363	P=0.161
Stink socks/Sweat	P=0.321	P=0.244	P=0.448	P=0.449
Condensed milk	P=0.491	P=0.018*	P=0.066	P=0.710
Fried garlic	P=0.019*	P=0.359	P=0.461	P=0.312

In addition, the odor that showed a statistically significant difference between male and female in 2022 was rose (p = 0.036), and it was difficult for male to understand the odor compared to female.

Discussion

In this study, we conducted a comparison of taste test results, olfactory test results, and questionnaire survey responses for the same participants before and after the COVID-19 epidemic, during annual health checkups for residents in Yakumo, Hokkaido, Japan, where population movement is limited. We examined post-2019 (pre-COVID-19 epidemic) and 2022 (post-COVID-19 epidemic) outcomes for subjective dizziness, tinnitus, headache, taste, smell, and salivation among 42 males and 58 females. The results were compared, and no statistical significance was observed for any of the mentioned items.

We also compared post-2019 (pre-COVID-19 epidemic) and 2022 (post-COVID-19 epidemic) taste test and olfactory test results among 42 males and 58 females. The taste test results did not show any statistically significant difference. However, the olfactory test results exhibited a reduction in 2022 compared to 2019, with a statistically significant decrease in the number of recognizable odors.

Past research has indicated that males perform less well on olfactory tests compared to females [1-5], and there is a statistically significant decline in olfactory perception with advancing age [1-5]. We have previously reported that taste test results remain consistent across different ages for both males and females. Recent reports have highlighted cases demonstrating anomalies in the sense of taste and smell due to the COVID-19 epidemic [7-16].

It remains unclear whether the observed decline in the sense of smell, as revealed in this study, is primarily a result of the aging process over the three-year period or if it has been influenced to a significant extent by the COVID-19 epidemic. Further follow-up involving an additional 100 participants will be essential to gain deeper insights in the future.

Conclusion

Taste and smell test results, along with questionnaire survey responses, were compared in the same participants before and after the COVID-19 epidemic (2019 and 2022: 42 males and 58 females). The findings revealed that there was no statistically significant difference in the taste test results. However, the olfactory test results indicated a lower value in 2022 compared to 2019, accompanied by a reduced ability to recognize odors. Nonetheless, this study does not conclusively determine whether the decline in the sense of smell is attributed to the natural aging process over the three-year period or if it is influenced by the impact of the COVID-19 epidemic. To gain more insights, further follow-up investigations are necessary in the future.

Ethics Statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Nagoya University School of Medicine (approval number 2014–0207). The participants provided their written informed consent to participate in this study.

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Conflict of Interest

The author has read and approved the final version of the manuscript. The author has no conflicts of interest to declare.

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