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**Przebieg zachorowania na COVID-19
w odniesieniu do zmysłu węchu,
smaku i wzroku**

The SARS-CoV-2 virus
contributes to disorders of the
sense of smell, taste and vision
by attacking many important
structures in human body

Znaczenie systematycznej rehabilitacji na przestrzeni 45 lat pacjentki z rozwojową dysplazją stawu biodrowego

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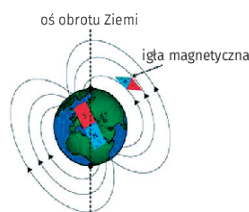
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Komentarz ten jest moim osobistym świadectwem zadowolenia z produktów biomagnetycznych „Ort Butterfly”, których używam od 20. lat! Zastanawiam się, zwłaszcza nad fenomenem poduszki (określenie nie jest przypadkowe) zwyczajnie; nie wyobrażam sobie snu i wypoczynku bez magnetycznej „Ort Butterfly” – pod głową! Jej ergonomiczny, przyjazny dla głowy i szyi kształt sprawia, że wysypiam się „po królewsku”. Zabieram ją również ze sobą w bliższe i dalsze podróże! Czyż gdyby była to zwyczajna poduszka, fundowałbym sobie dodatkowy bagaż? Wychwalam więc ją od zarania, polecam i rekomenduję, bo jest tego warta! Bez niej nie wyobrażam sobie prawdziwie relaksacyjnego snu i błogiego, kojącego wypoczynku! Dziękuję, że ją Pani stworzyła!

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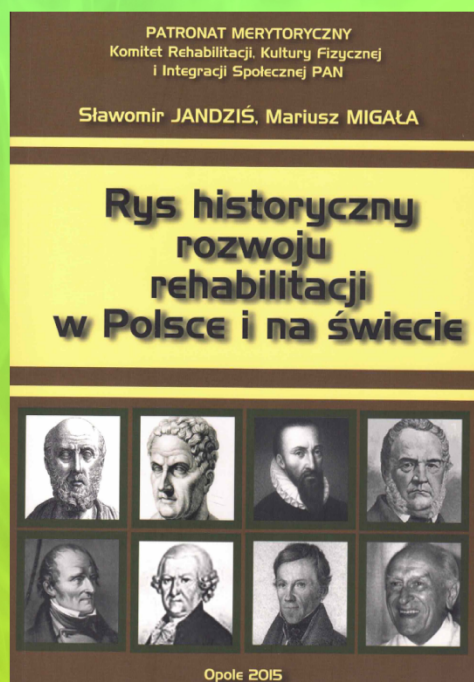
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The SARS-CoV-2 virus contributes to disorders of the sense of smell, taste and vision by attacking many important structures in human body

Przebieg zachorowania na COVID-19 w odniesieniu do zmysłu węchu, smaku i wzroku

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Abstract

Introduction. The SARS-CoV-2 virus contributes to disorders of the sense of smell, taste and vision by attacking many important structures in human body.

Aim of the study The aim of this study was to investigate whether there is a relationship between COVID-19 infection and disorders of the sense of smell, taste and vision.

Material and methods The study included 368 subjects (168 who did not meet the inclusion criteria were excluded) ranging in age between 25-55 years. (mean age 38 +/-9.45), women represented 59.5% and men 40.5% of the study group. An author's survey questionnaire posted on ankieto.pl was used. SPSS Statistics program was used for statistical analysis. The level of statistical significance was taken as $p < 0.05$.

Results. The collected data showed that loss of taste in the course of COVID-19 infection affected 66.1%, and loss of smell affected 58.9% of the study group. Symptoms lasted from 3-5 days and involved 31% loss of taste and 58.9% loss of smell. Respondents reported experiencing visual disturbances in 64%.

Conclusions. COVID-19 infection has been shown to be significantly associated with loss of smell and taste. In addition, there are visual disturbances, the most common of which are decreased visual acuity and blurred vision.

Key words:

COVID-19, SARS-CoV-2 pandemic, sensory disorders

Streszczenie

Wstęp. Wirus SARS-CoV-2 przyczynia się do wystąpienia zaburzeń w obrębie zmysłu węchu, smaku i wzroku, atakując na swojej drodze wiele ważnych dla organizmu struktur.

Cel pracy: Celem pracy było zbadanie, czy istnieje zależność pomiędzy zachorowaniem na COVID-19 a zaburzeniami w obrębie zmysłu węchu, smaku i wzroku.

Materiał i metody. W badaniu wzięło udział 368 osób (wykluczono 168 niespełniających kryteriów włączenia) w wieku od 25. do 55. r.ż. (średnia 38 lat \pm 9,45), kobiety stanowiły 59,5%, a mężczyźni 40,5% badanej grupy. Wykorzystano autorski kwestionariusz ankiety zamieszczony na portalu ankieto.pl. W celu przeprowadzenia analizy statystycznej posłużono się programem SPSS Statistics. Za poziom istotności statystycznej przyjęto $p < 0,05$.

Wyniki. Z zebranych danych wynika, że utrata smaku w przebiegu zarażenia COVID-19 dotyczyła 66,1%, a utrata węchu 58,9% grupy badanej. Objawy utrzymywały się od 3 do 5 dni i w 31% dotyczyły utraty smaku, a w 58,9% utraty węchu. Ankietowani zgłaszali występowanie zaburzeń widzenia w 64%.

Wnioski. Wykazano, że zarażenie COVID-19 ma istotny związek z utratą węchu i smaku. Dodatkowo występują zaburzenia wzroku, spośród których najczęstsze to spadek ostrości widzenia oraz przysłonięte widzenie.

Słowa kluczowe:

COVID-19, pandemia SARS-CoV-2, zaburzenia narządów zmysłów

Introduction

Smell and taste abnormalities correlated with COVID-19 disease are most likely due to the fact that the olfactory epithelium of the nasal cavity is a place of increased SARS-CoV-2 virus binding. The supporting cells are characterized by high expression of the cellular receptors TMPRSS2 and ACE-2 which allows SARS-CoV-2 virus to bind and enter the cells. When these cells become damaged, taste and smell abnormalities are most likely to occur in COVID-19 disease [1]. The suggested coexisting mechanism is based on the neurotropic properties of coronaviruses. The NRP1 receptor, which is expressed on olfactory sensory neurons presumably facilitates direct damage and axonal transport to the olfactory bulb [2].

Anatomical and functional changes in SARS-CoV-2 infection can occur in several ways. The virus is able to directly invade the brain of patients, with the help of the olfactory nerve reaching the brainstem and its other areas. It also enters the cerebrospinal fluid. Occasionally, brain infection occurs from the interruption of peripheral nerves as a consequence of a breach in skin continuity [3]. The presence of coronavirus-2 has been confirmed in microglia, neurons, endothelial cells, astrocytes, neural stem cells and ependymal cells [4].

Aim of the study

The aim of this study was to investigate whether there is a correlation between COVID-19 incidence and abnormalities in the senses of smell, taste and vision.

Material and methods

A proprietary survey questionnaire was prepared to investigate whether there is a relationship between COVID-19 incidence and disorders in the senses of smell, taste and vision. In order to assess the reliability of the questionnaire before the actual study was performed, it was published on ankieteo.pl in the first half of April 2021. The actual survey was published on the aforementioned portal again in the first half of May 2021. There were no significant differences between the results obtained in the two samples ($p < 0.05$).

A total of 368 people participated in the survey (168 people were excluded). The exclusion criteria were age below 25 and above 55. Among the eligible subjects, there were 59.5% women ($n = 119$) and 40.5% men ($n = 81$) with a mean age of 38. (standard deviation ± 9.45).

Of the 200 individuals enrolled in the study, 28% ($n = 56$) had undergone COVID-19 which constituted the study group. Those without COVID-19 disease constituted a comparison group of 72% ($n = 144$ people).

The study used an online author's diagnostic survey, which consisted of 43 questions. The question that classified the subjects into a group of COVID-19 post-infection (study group) and a group of previously non-infected subjects (comparison group) was a question about COVID-19 infection.

The subjects were informed what the study was about and that all of the posted questions had to be answered. The second

was a question about age, which excluded those who did not meet the study criteria.

This was followed by a question about COVID-19 infection. In the case of infection, the questions concerned:

- diagnosis of infection in the form of a test for COVID-19 and anti-SARS-CoV-2 antibodies
- the duration of COVID-19 symptoms
- symptoms occurring from the organ of vision,
- symptoms of taste,
- symptoms occurring from the olfactory organ,

The last part of the survey consisted of questions about the loss of smell, taste, vision in the group of COVID-19 uninfected subjects.

Statistical analysis was prepared using MS EXCEL and SSPS Statistics. Chi-square test was performed, and $p < 0.05$ was taken as the level of significance. Also, comparisons and analysis of both groups were used.

Results

After performing the Chi-square test of independence, it was found that there was a significant relationship between the presence of sensory disorders and the incidence of COVID-19.

Olfactory abnormalities

It was shown that olfactory loss in the course of COVID-19 infection was present in 58.9% of the respondents, while in healthy non-COVID-19 subjects it was 4.9% ($p < 0.05$).

Table 1. Prevalence of olfactory loss in COVID-19 infected subjects based on the author's survey questionnaire

		Have you lost sense of smell?			
			Yes	No	Total
Were you infected COVID-19?	Yes	Number of respondents	33	23	56
		Were you infected COVID-19?	58.9%	41.1%	100.0%
	No	Number of respondents	7	137	144
		Were you infected COVID-19?	4.9%	95.1%	100.0%
Total		Number of respondents	40	160	200
		Were you infected COVID-19?	20.0%	80%	100.0%

Table 2. Pearson's Chi-square test for the presence of a relationship between COVID-19 incidence and olfactory loss

	df	Asymptotic significance (two-sided)
Pearson's chi-square	1	0.000

After statistical analysis using the Chi-square test (Table 2), a relationship was found between the above variables ($p < 0.05$).

The results of the study show that olfactory loss in COVID-19-infected individuals was most common between 3–5 days and represented 31% of the study group.

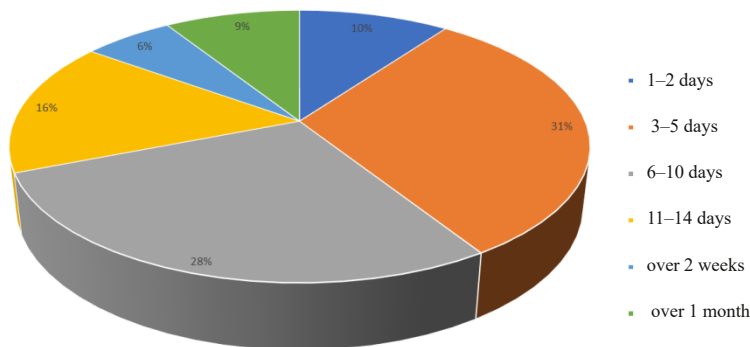


Figure 1. Duration of olfactory loss expressed in time interval based on the author's survey questionnaire

Disorders of the organ of taste

Loss of taste in the COVID-19 group affected 66.1%, while appearing in 6.9% of the non-diseased group.

Table 3. Occurrence of taste loss in COVID-19 infected group based on author's survey questionnaire

		Have you lost sense of taste?		Total	
		Yes	No		
Were you infected COVID-19?	Yes	Number of respondents	37	19	56
		Were you infected COVID-19?	66.1%	33.9%	100.0%
	No	Number of respondents	10	134	144
		Were you infected COVID-19?	6.9%	93.1%	100.0%
Total		Number of respondents	47	153	200
		Were you infected COVID-19?	23.5%	76.5%	100.0%

Table 4. Pearson's Chi-square test for the presence of a relationship between COVID-19 incidence and taste loss

	df	Asymptotic significance (two-sided)
Pearson's chi-square	1	0.000

After statistical analysis using the Chi-square test (Table 4), a relationship between the above variables was found ($p < 0.05$). It was investigated that loss of taste among those infected with COVID-19 ($n = 37$) was most common ranging 3–5 days.

Occurrence of symptoms from the organ of sight

Visual impairment in COVID-19 infection was found to occur in 64% of respondents.

The study found that the most common ocular symptom of COVID-19 infection is decreased acuity (60%), blurred vision (45%) and pain behind the eye (40%).

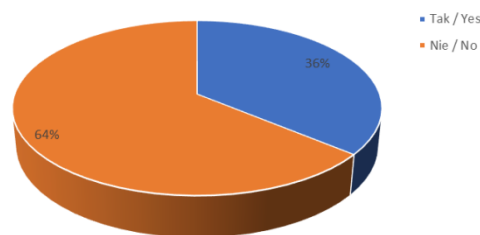


Figure 2. Occurrence of ocular symptoms in a group of COVID-19 infected persons based on the author's survey questionnaire

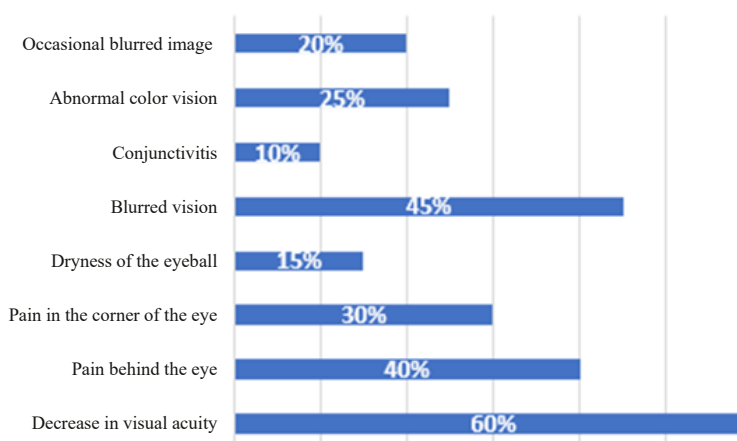


Figure 3. Ocular symptoms occurring during COVID-19 infection based on the author's survey questionnaire

Discussion

The most common sensory symptoms are loss of smell and taste. A study by Lechien et al. examined 417 patients from 12 European hospital centers. In the study group, as many as 85.6% of patients had olfactory disorders associated with infection [5]. A similar conclusion was reached by Kay et al. who studied 237 patients after which they concluded that anosmia (loss of smell) occurred even before the diagnosis of COVID-19 in 73% of the subjects, and was the first symptom in 26.6% [6].

The most comprehensive meta-analysis was performed by Saniasiai et al. It consisted of 83 studies with data from 27492 patients, which concluded that olfactory disturbances affected 47.85% of patients infected with COVID-19, anosmia (loss of smell) affected 35.39% [7]. On the other hand, Amorim Dos Santos et al. in a systematic review of 40 studies (10228 patients), showed that taste disorders were reported by 45% of patients infected with COVID-19. Ageusia (lack of taste) affected 24% [8]. A meta-analysis by Agyeman et al. which included 24 studies from 13 countries, found that among 8438 patients with COVID-19 symptoms, 41% complained about olfactory disturbances, and taste disturbances were reported by 38.2% [9].

Comparing our own study with the study above, loss of smell was reported by 58.9% and loss of taste by 66.1% of the study group. It can be noted that more than half of those infected lost smell/taste.

The return of olfactory function varied; in the patients studied by Lechien et al. it was usually 5-8 days [10]. In contrast, in the

present study, respondents reported lack of olfactory function between 3-5 days in 30.3%, between 6-10 days in 28%, and between 11-14 days in 16%. The differences may be due to the fact that our own study used different time intervals in the survey questionnaire for the return of olfactory function. Other results were reached by von Bartheld et al. According to them, olfactory disturbances lasted an average of 9.03 days \pm 1.32, while taste disturbances lasted 12.64 days \pm 2.51 [11]. In our study, respondents reported persistence of taste loss for 3-5 days in 32.4%, for 6-10 days in 28%, and for 11-14 days in 16%.

Taste disturbances in Lechien et al. were reported by 88.8% of respondents [5], while 66.1% in the study presented here.

In this study, respondents were asked about the presence of ocular disorders. Of the study group, 35.7% responded that they had ocular symptoms during infection. In the study conducted by Pardhan et al. it was proven that ocular symptoms were noted in those infected. The three most common ocular symptoms reported by participants were photophobia 18%, eye pain 16% and eye itching 17% [12]. The associated ocular condition with COVID-19 infection is believed to be conjunctivitis [13]. Separating environmental factors from the infection itself is very difficult, and spending several hours in front of a computer and in enclosed spaces can lead to an increase in visual defects of young people and worsen ocular accommodation [14]. Nevertheless, in our study, a decrease in visual acuity occurred in 60% of the subjects and hazy vision in 45%, in a review of the literature we can find confirmation that the above symptoms are reported by COVID-19 patients [15]. Causes may include fatigue, which occurs frequently, treatment with steroid drugs, corneal edema, impaired oxygen transport to ocular tissues or circulation problems. It has additionally been noted that oculomotor nerve palsy occurs among patients infected with COVID-19 [16]. It is worth noting that dry eye problems are occurring more frequently. This problem can be caused by wearing masks, using electronic devices for long periods of time, or using oxygen masks for hospitalized patients [17]. In our study, dry eye during COVID-19 infection was reported by 15% of respondents. Being forced to stay indoors in the SARS-CoV-2 pandemic, spending long hours in front of screens, limiting interpersonal contact and less exposure to natural light caused visual system problems [18, 19]. Visual deterioration may also be caused by increased long-term stress levels mediated by increased cortisol levels [20]. The effect of COVID-19 disease on visual impairment is yet to be studied, but at this point ophthalmic symptoms in infected patients range from 5% to 26% [21]. The most common symptom coexisting with COVID-19 is conjunctivitis, the frequency ranging up to 31.6% [22]. In our study, conjunctivitis was present in 10% of subjects.

Conclusions

The study showed that there is a relationship between COVID-19 incidence and sensory disorders.

Analysis of the results led to the following conclusions:

1. The study showed that COVID-19 infection has a significant impact on olfactory organ disorders.
2. The present study concluded that COVID-19 infection affects taste disorders.

3. COVID-19 infection was found to affect disorders of the organ of sight.
4. It was shown that the most common symptoms of ocular disorders are decreased visual acuity and blurred vision.

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