Influence of nasal mucosa irritants on the occurrence of chronic rhinosinusitis without /and with polyps

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ABSTRACT: Introduction: The aim of the study was to assess the effect of nasal mucosa irritants on the occurrence of chronic rhinosinusitis without/and with nasal polyps.

Material and methods: The study involved 100 adult participants, including 39 women and 61 men, aged 21–68, diagnosed and treated at the Department of Otolaryngology, ENT Oncology, Audiology and Phoniatrics at the University Clinical Hospital WAM in Łódź. Based on the otorhinolaryngological and imaging (CT) tests they were divided into two groups: I – 50 patients, including 23 women and 27 men, aged 21–64 – with chronic rhinosinusitis without nasal polyps, II – 50 patients, including 16 women and 34 men, aged 22–68 – with chronic rhinosinusitis with nasal polyps. The control group consisted of 50 people (group III), including 25 women and 25 men, aged 18–30, students of the Faculty of Military Medicine at the Medical University of Lodz. All respondents completed a prepared questionnaire consisting of 17 questions addressed in the form of an anonymous interview among patients treated in the Department of Otolaryngology, ENT Oncology, Audiology and Phoniatrics.

Results: The conducted surveys indicate the impact of the following factors in pathogenesis of chronic rhinosinusitis without/with nasal polyps: exogenous factors (viruses, bacteria, fungi, drugs, injuries, toxic substances, environmental pollution), general endogenous factors (allergy, hypersensitivity to acetylsalicylic acid and its derivatives, hormonal disorders, supræesophageal reflex disease, granulation disease, immunity disorders, local endogenous factors.

Conclusions: In the examined material, patients with chronic rhinosinusitis without/and nasal polyps in most cases are in the age range 51–60 years and over 60 years, they most often live in large cities over 250 thousand inhabitants, suffer from allergic rhinorhinitis in 38.0% in group I and 36.0% in group II, rapid temperature changes and dry air have a negative impact on comfort of breathing. The conducted surveys confirm that the cause of chronic rhinosinusitis with polyps is multifactorial, but a significant factor affecting typical tissue remodeling in this disease is long-term breathing of polluted atmospheric air.

KEYWORDS: chronic rhinosinusitis with/without nasal polyps, irritants, nasal mucosa

ABBREVIATIONS

CRS – chronic rhinosinusitis
CRSwNP – CRS without nasal polyps
CRSwNP – CRS with nasal polyps
CT – computed tomography
ECP – Epidemiology of Allergic Diseases in Poland
ECAP – eosinophil cationic protein
ESS – endoscopic sinus surgery

INTRODUCTION

As shown by ECAP (Epidemiology of Allergic Diseases in Poland) studies conducted by a team of Professor Bolesław Samoliński, 36.08% of the Polish society suffers from rhinitis, thus 14.5 million Poles experience periodical or permanent disability of nasal function [1]. It is estimated that there are about 200 million people worldwide suffering from rhinitis. The prevalence of rhinitis in rural areas has been evaluated in ECAP studies at 16.0%, and 22.9% in highly urbanized areas [1].

Chronic rhinitis is an inflammatory condition of the nasal mucosa which persists for over 12 weeks. It may be a consequence of acute and recurrent viral infections of the nose and paranasal sinuses. Chronic rhinitis may occur in a variety of ways and, if left untreated, may lead to many complications. In general, the nasal mucosa has cilia that are responsible for self-cleaning and the production of secretions that moisturize the epithelium and remove all impurities. Cilia cause the secretion to be excreted outside [2].

The most common cause of impaired patency of the paranasal sinus is a previous viral infection of the nasal mucosa, but there are also other non-infectious factors that could lead to the development of this disease. A distinction is drawn between:
allergic rhinitis, anatomical defects, especially in the structure of the nasal septum and lateral wall, disturbances in the functioning of the ciliary cells responsible for mucus transport (e.g. in the course of cystic fibrosis), gastroesophageal reflux and laryngopharyngeal reflux, congenital and acquired immunodeficiency, excessive exposure to tobacco smoke, dust, and air pollution. The risk factors also include: presence of polyps, tumors and perforation of the nasal septum [3].

There are many hypotheses explaining the formation of polyps [4–7]. In 1896, Hayek assumed that polyps result from the formation of exudate that pushes out the mucosa, leading to local hyperemia, swelling and stagnation of blood in the vessels [2]. In 1907, Yonge described another cause, namely cystic distension of the mucous glands (caused by their excessive activity and chronic inflammation), which was to mechanically press on local blood vessels and the glands themselves, leading to swelling and hyperemia [2]. In the most recent hypotheses, attention was drawn to the significance of isolated damage to the epithelium and its basal membrane associated with inflammation as a signal to initiate polyogenesis [7].

On the other hand, Bernstein [4] brought forward an interesting concept of disturbances in the function of ion channels in the epithelial cell membrane, including excessive absorption of Na+ ions and increased permeability of Cl- ions. He argued that increased transepithelial ion transport, enhancing the movement of water to the interstitial spaces, induces nasal swelling and the formation of polyps.

Currently, the pathogenetic factors of chronic paranasal rhinosinusitis with nasal polyps include [8–12]:

- exogenous factors (viruses, bacteria, fungi, drugs, injuries, toxic substances, environmental pollution),
- general endogenous factors (allergy, hypersensitivity to acetylsalicylic acid and its derivatives, hormonal disorders, gastroesophageal reflux, diseases with granulation tissue formation, immunity disorders, genetic syndromes of ciliary mobility disorders (Kartagener’s syndrome, cystic fibrosis), edematous causes,
- local endogenous factors (anatomical anomalies, enlarged bulla ethmoidalis, inflated and enlarged middle turbinate, deviated septum), tumors, acquired syndromes of respiratory epithelium mobility disorders.

The aim of this study was the evaluation of the impact of irritants of the nasal mucosa on the occurrence of chronic rhinosinusitis (CRS) without and with nasal polyps.

**MATERIAL AND METHODS**

Trials were conducted in 100 adults, including 39 women and 61 men aged 21–68, and diagnosed and treated at the Department of Otolaryngology, Laryngological Oncology, Audiology and Phoniatrics of the Central Clinical Hospital of the Medical University in Łódź WAM in Łódź, who were divided into two groups on the basis of otorhinolaryngological examination and imaging tests (CT):

- I – 50 patients (study group), including 23 women and 27 men, aged 21–64 (average age – 48.3 years) – with chronic rhinosinusitis without nasal polyps,
- II – 50 patients (study group), including 16 women and 34 men, aged 22–68 years (mean age – 56.6 years) – with chronic rhinosinusitis with nasal polyps.

The benchmark groups comprised 50 people (group III), including 25 women and 25 men, aged 18–30 (average age – 23.5) who were students of the Military Medical Faculty of the Medical University of Lodz (healthy).

All subjects completed a questionnaire consisting of 17 questions in the form of an anonymous interview among patients treated at the Department of Otolaryngology, Laryngological Oncology, Audiology and Phoniatrics of the Central Clinical Hospital of the Medical University in Łódź (after obtaining the consent of the Director of the Hospital).

The questionnaire covered the following topics: age, gender, place of residence, education, incidence, occurrence of allergic rhinitis and paranasal rhinosinusitis, hypersensitivity to inhalation and/or food allergens, incidence; allergy to non-steroidal anti-inflammatory drugs, bronchial asthma, gastroesophageal reflux disease, irritants affecting the comfort of breathing, the impact of irritants on rhinitis, assessment of air pollution, assessment of the air condition in one’s town, occurrence of nasal symptoms, type of pharmacological treatment used, body weight, stimulants used.

The results were statistically analyzed using the Ch2 test of independence. Statistically significant results were recognized when the level of significance was lower than 5 percentage points (p < 0.05).

**RESEARCH RESULTS**

The research was carried out in a total of 150 people; the age range of respondents was as follows: in group I (with chronic paranasal rhinosinusitis without nasal polyps): 18–30 years – 10 patients (4 women and 6 men), 31–40 years – 10 patients (4 women and 6 men), 41–50 years – 10 patients (6 women and 4 men), 51–60 years – 8 patients (3 women and 5 men) and over 60 years – 12 patients (6 women and 6 men), in group II (with chronic paranasal rhinosinusitis with nasal polyps): 18–30 years old – 3 patients (2 women and 1 man), 31–40 years – 7 patients (2 women and 5 men), 41–50 years – 8 patients (4 women and 4 men), 51–60 years – 16 patients (4 women and 12 men) and over 60 years old – 16 patients (4 women and 12 men), while group III (reference) included students aged 18–30 (25 women and 25 men).

Both in groups I and II, patients lived in large cities over 250,000: 20 (40%) and 24 (48.0%), respectively, while rural areas were a place
Tab. I. Summary of respondents depending on known hypersensitivity to inhaled and/or food allergens and gender.

<table>
<thead>
<tr>
<th>KNOWN HYPERSENSITIVITY TO ALLERGENS</th>
<th>INHALATORY</th>
<th>DIGESTIVE</th>
<th>INHALATORY AND DIGESTIVE</th>
<th>NOT ALLERGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>M</td>
<td>K</td>
<td>M</td>
</tr>
<tr>
<td>GROUP I</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Chronic rhinosinusitis without nasal polyps</td>
<td>4 8.0</td>
<td>7 14.0</td>
<td>1 2.0</td>
<td>1 2.0</td>
</tr>
<tr>
<td>Chronic rhinosinusitis with nasal polyps</td>
<td>1 2.0</td>
<td>4 8.0</td>
<td>- -</td>
<td>1 2.0</td>
</tr>
<tr>
<td>References</td>
<td>2 4.0</td>
<td>3 6.0</td>
<td>2 4.0</td>
<td>- -</td>
</tr>
</tbody>
</table>

Tab. II. Summary of respondents depending on the presence of irritants that affect respiratory comfort.

<table>
<thead>
<tr>
<th>OCCURRENCE OF IRRITATING FACTORS</th>
<th>RAPID TEMPERATURE CHANGES</th>
<th>SUDDEN CHANGES OF AIR PRESSURE</th>
<th>DRY AIR</th>
<th>INTENSE SMELLS</th>
<th>SPICY FOODS</th>
<th>SEXUAL EXCITEMENT</th>
<th>STRESS</th>
<th>MEDICINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic rhinosinusitis without nasal polyps</td>
<td>17 13</td>
<td>7 6</td>
<td>13 16</td>
<td>8 2</td>
<td>5 2</td>
<td>- 2</td>
<td>4 3</td>
<td>1 -</td>
</tr>
<tr>
<td>Chronic rhinosinusitis with nasal polyps</td>
<td>9 19</td>
<td>2 7</td>
<td>11 16</td>
<td>4 4</td>
<td>2 1</td>
<td>2 -</td>
<td>5 1</td>
<td>3 2</td>
</tr>
<tr>
<td>References</td>
<td>11 14</td>
<td>4 2</td>
<td>14 16</td>
<td>12 8</td>
<td>6 6</td>
<td>3 1</td>
<td>6 5</td>
<td>2 -</td>
</tr>
</tbody>
</table>

Fig. 1. Summary of respondents depending on the incidence of allergic rhinosinusitis and gender.

of residence in 10 (20.0%) and 12 (24%), respectively. Similarly, in group III there were 24 people (48%) who lived in cities of over 250,000 and 11 people (22.0%) in rural areas.

In group I, 25 patients (50.0%) and 22 patients (44.0%) achieved full secondary education, while in group II persons with basic vocational education prevailed – 15 (30.0%), and secondary and higher education – 12 (24.0%) and 9 (18.0%), respectively.

In turn, the analyzed annual incidence of upper respiratory tract infections was as follows: in group I, respectively 1–2 in 18 cases (in 4 women and 14 men), 3–4 times in 16 cases (in 10 women and 6 men) and 5 times and more in 11 cases (in 7 women and 4 men), in group II, 20 (6 women and 14 men), 10 (5 women and 5 men) and 12 (4 women and 8 men), respectively, while in group III, 24 (12 women and 12 men), 18 (7 women and 11 men) and 5 (4 women and 1 man). Five people (10.0%) in group I, 8 people (16.0%) in group II and 3 people (6.0%) in group III did not suffer from illness.

The diagram in Fig. 1. shows that allergic rhinosinusitis affects: 19 (38%) people (11 women and 8 men) from group I, 18 (36.0%) people (6 women and 12 men) and 8 people (16.0%) (2 women and 6 men).

In group I, 36 (72.0%) patients (17 women and 19 men) reported that they had no allergies, in group II, 40 (80.0%) patients (13 women and 27 men), and in group III, respectively 40 (80.0%) people (20 women and 20 men). Among allergy sufferers there prevailed reactions to inhaled allergens, respectively in 11 cases (22.0%) in group I, in 5 cases (10.0%) in group II and in 5 cases (10.0%) in group III (Tab. I).

Allergy to nonsteroidal anti-inflammatory drugs was reported by 4 (8.0%) patients from group I and 5 patients (10.0%) from group II. There was a statistically significant correlation between the occurrence of allergy to NSAIDs and its absence in individual study groups (p < 0.05, p < 0.05 and p < 0.05).

The presence of bronchial asthma was reported by 4 (8.0%) patients from group I, 10 patients (20.0%) from group II and 4 (8.0%)
patients from group III. A statistically significant correlation was found between the occurrence of bronchial asthma and its absence in individual study groups (p < 0.05, p < 0.05 and p < 0.05).

In turn, gastroesophageal reflux disease occurred in 11 (22.0%) patients in group I, 7 (14.0%) patients in group II and 3 (6.0%) patients in group III. A statistically significant correlation was found between the occurrence of gastric reflex disease and its absence in individual study groups (p < 0.05, p < 0.05 and p < 0.05).

When examining the impact of irritating factors influencing breathing comfort (Tab. II.) patients most frequently reported rapid temperature changes in 30 cases (17 women and 13 men) and dry air in 29 cases (13 women and 16 men) in group I and in 28 cases (9 women and 19 men) and in 27 cases (11 women and 16 men) in group II, while in group III, respectively in 25 cases (11 women and 14 men) and 30 cases (14 women and 16 men). We affirmed the statistical association between rapid changes in temperature and dry air and other factors irritating the nasal mucosa in particular groups (p < 0.05, p < 0.05 and p < 0.05).

Among irritating factors influencing rhinitis, the respondents most often reported (Tab. III.): in group I – a cold in 42 (84.0%) cases (19 women and 23 men), a decrease in immunity in 17 (34.0%) cases (10 women and 7 men) and air pollution in 14 (28.0%) cases (9 women and 5 men), in group II, in 43 (86.0%) cases, respectively (15 women and 28 men), in 9 (18.0%) cases (5 women and 4 men) and in 15 (30.0%) cases (3 women and 12 men), while in group III, in 40 (80.0%) cases (21 women and 19 men), respectively, in 34 (68.0%) cases (18 women and 16 men) and in 13 (26.0%) cases (8 women and 5 men).

Both in group I and II, the patients most often reported air pollution as medium and high (Tab. IV.), respectively in 21 (42.0%) cases (10 women and 11 men) and in 21 (42.0%) cases (9 women and 12 men) and in 16 (32.0%) cases (7 women and 9 men) and in

<table>
<thead>
<tr>
<th>OCCURRENCE OF IRRITATING FACTORS ON RHINOSINUSITIS</th>
<th>DECREASE IN IMMUNITY</th>
<th>OVERTIREDNESS</th>
<th>STRESS</th>
<th>COLD</th>
<th>MALNUTRITION</th>
<th>AIR POLLUTION</th>
<th>SMOKING, OVERUSE OF ALCOHOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP I Chronic rhinosinusitis without nasal polyps</td>
<td>10</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>19</td>
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<tr>
<td>GROUP I Chronic rhinosinusitis with nasal polyps</td>
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<td>GROUP III References</td>
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</tbody>
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<table>
<thead>
<tr>
<th>ASSESSMENT OF AIR POLLUTION</th>
<th>VERY HIGH</th>
<th>HIGH</th>
<th>AVERAGE</th>
<th>SMALL</th>
<th>EXCEPTIONALLY CLEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP I Chronic rhinosinusitis without nasal polyps</td>
<td></td>
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<tr>
<td>GROUP II Chronic rhinosinusitis with nasal polyps</td>
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<tr>
<td>GROUP III References</td>
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</table>

Fig. 2. Summary of respondents depending on the condition of air in their town and gender.
The summary in Tab. VI. indicates that no pharmacological treatment was used in 19 (38.0%) cases (4 women and 15 men) in group I, in 10 (20.0%) cases (5 women and 5 men) in group II and 12 (24.0%) cases (7 women and 5 men) in group III. A statistical relationship was found between the lack of treatment and groups I and II (p < 0.05) and between gender in group I (p < 0.05).

The use of oral and topical inhaled steroids was similar in groups I and II, in 25 (50.0%) cases and in 23 (46.0%) cases, while in group II in 14 (28.0%) cases. A statistical relationship was found between the use of steroids and gender in group II (p < 0.05).

In turn, medicines exsanguinating the nasal mucosa (Tab. VI.) were most often used by people from group III, as many as 28 (56.0%) cases, compared to groups I and II, respectively in 11 (22.0%) cases and in 21 (42.0%) cases. A statistical relationship was found between the use of medicines exsanguinating the nasal mucosa in groups I and III (p < 0.05) and between gender in group I (p < 0.05).

The summary in Tab. VI. indicates that no pharmacological treatment was used in 19 (38.0%) cases (4 women and 15 men) in group I, in 10 (20.0%) cases (5 women and 5 men) in group II and 12 (24.0%) cases (7 women and 5 men) in group III. A statistical relationship was found between the lack of treatment and groups I and II (p < 0.05) and between gender in group I (p < 0.05).

The use of oral and topical inhaled steroids was similar in groups I and II, in 25 (50.0%) cases and in 23 (46.0%) cases, while in group II in 14 (28.0%) cases. A statistical relationship was found between the use of steroids and gender in group II (p < 0.05).

In turn, medicines exsanguinating the nasal mucosa (Tab. VI.) were most often used by people from group III, as many as 28 (56.0%) cases, compared to groups I and II, respectively in 11 (22.0%) cases and in 21 (42.0%) cases. A statistical relationship was found between the use of medicines exsanguinating the nasal mucosa in groups I and III (p < 0.05) and between gender in group I (p < 0.05).

Normal body weight was found more often in group III than in groups I and II (Fig. 4.), in 42 (84.0%) cases (23 women and 19 men), 20 (40.0%) cases (8 women and 12 men) and in 12 (24.0%) cases (4 women and 8 men). A statistical relationship was found between groups I and III as well as II and III and the normal body weight (p < 0.05 and p < 0.05).
Considerable overweight was observed more often in group I than II, in 21 (42.0%) cases (10 women and 11 men) and 16 (32.0%) cases (5 women and 11 men), respectively.

A statistical relationship was found between groups I and III as well as II and III and significant overweight (p < 0.05 and p < 0.05).

Eighteen patients (36.0%) from group I were smokers (7 women and 11 men), 11 (22.0%) patients (4 women and 7 men) from group II and 14 (28.0%) patients from group III (4 women and 10 men). A statistical relationship was found between smokers and non-smokers in the studied groups (p < 0.05, p < 0.05 and p < 0.05).

Most respondents drank coffee and tea (Fig. 4.), respectively in 47 (94.0%) cases (21 women and 26 men) in group I, in 43 (86.0%) cases (13 women and 30 men) in group II and in 41 (82.0%) cases (20 women and 21 men) in group III. A statistical correlation was found between people drinking coffee and tea, and those who did not consume it in the studied groups (p < 0.05, p < 0.05 and p < 0.05).

Alcohol was consumed by only 6 (12.0%) patients (1 woman and 5 men) in group I and 10 (20.0%) patients (2 women and 8 men) in group II. For comparison, in group III alcohol was consumed in 16 (32.0%) cases (6 women and 10 men). A statistical relationship was found between people who drink alcohol and the non-users in the studied groups (p < 0.001, p < 0.05 and p < 0.05).

**DISCUSSION**

According to the European Guidelines (EPOS 2012), chronic rhinosinusitis is defined as the occurrence of two symptoms for more than 12 weeks, one of which is nasal obstruction or anterior and/or posterior nasal drip.

In the studied material, the most common nasal symptoms were nasal obstruction and nasal discharge, respectively: in 90.0% of cases and in 68.0% of cases in group I, in 94.0% of cases and in 60.0% of cases in group II, and in 74.0% of cases and in 66.0% of cases in group III, i.e. the reference. However, the described symptoms were due to vasomotor rhinitis, as it concerned students aged 18–30. Symptoms characteristic of allergic rhinitis, such as sneezing, watery eyes and itchy nose, were similar in groups I and II.

The local use of oral and inhaled steroids was similar in groups I and II, respectively in 50.0% of cases and in 46.0% of cases, while in group II in 28.0% of cases. On the other hand, medicines exsanguinating the nasal mucosa were most often used by people from group III, as much as 56.0% of cases, compared to groups I and II, in 22.0% of cases and 42.0% of cases, respectively.

Normal body weight was found more often in group III than in groups I and II, in 84.0% of cases, in 40.0% of cases and in 24.0% of cases, respectively.

Considerable overweight was observed more frequently in group I than II, in 42.0% of cases and in 32.0% of cases, respectively, which was associated with the use of oral steroids.

In the pathophysiology of chronic paranasal rhinosinusitis, three main groups are described, depending on the immune response: Th1-weighted, Th2-weighted and Th17-weighted. Th1-weighted response (humoral) is related to: CRS without nasal polyps (CRSsNP), neutrophilia, elevated concentrations of myeloperoxidases, interferon gamma (IFN-γ), interleukin IL-2, and tumor necrosis factor (TNF-α).

Chronic rhinosinusitis with nasal polyps is usually associated with a Th-2- weighted cellular response, which is characterized by eosinophilia, elevated levels of: IL-2, IL-5, IL-10, IL-13 and ECP (eosinophil cationic protein). Th17 cell response is dominant in the Asian population, and is mainly related to CRS with nasal polyps (CRSwNP). Th17 response shows mainly increased cytokine expression: IL-6, IL-17, IL-22 and tumor necrosis factor TNFα [13–15].

Tissue remodeling is a dynamic process that results in a tem-
porary or permanent change in the histological composition of tissues. It may progress with the production or degeneration of the extracellular matrix, resulting in the formation of normal and/or pathological tissue [16]. The main histological features of tissue remodeling are: macrophages and lymphocyte migration, fibroblast proliferation, angiogenesis, subepithelial fibrosis and tissue degeneration. There are numerous studies showing that tissue remodeling also occurs in chronic paranasal sinus remodeling, and the features of stromal remodeling vary by type of inflammation [17].

Our research shows that 72.0% of patients in group I, 80.0% of patients in group II and 80.0% of patients in group III had no allergies. The majority of allergy sufferers reacted to inhaled allergens, respectively 22.0% in group I, 10.0% in group II and 10.0% in group III.

In turn, allergy to nonsteroidal anti-inflammatory drugs was reported by 8.0% of patients in group I and 10.0% of patients in group II.

The occurrence of bronchial asthma was reported by 8.0% of patients in group I, 20.0% in group II and 8.0% in group III.

Gastroesophageal reflux disease occurred in 22.0% of patients in group I, 14.0% of patients in group II and 6.0% of patients in group III.

The literature shows that the cause of chronic rhinosinusitis with nasal polyps is very complex and the pathomechanism has still not been fully explained.

Typical tissue remodeling in chronic paranasal rhinosinusitis with polyps is characterized by: pseudocyst formation, edema, albumin accumulation, decreased collagen content in the extracellular matrix and decreased expression of TGF β1, while in chronic paranasal rhinosinusitis without polyps there is an increased concentration of IFN-γ, TGF β1 and the collagen content in the extracellular matrix [18].

Workman et al. [19] published a list of biomarkers that are elevated in CRS. However, these biomarkers are not limited to CRS alone. They can be found in bronchial asthma or atopic dermatitis. Material for biomarker evaluation can be obtained from: peripheral blood, nasal secretions and nasal polyp tissue. The list of biomarkers includes: peripheral blood eosinophilia, IgE immunoglobulin, cytokines – IL-4, IL-5, IL-13, IL-25, IL-33, periostin, P-glycoprotein, CXCL-12, CXCL-13, matrix metalloproteinases.

Brescia et al. [20] demonstrated that tissue remodeling is a dynamic process with differences in the number of tissue eosinophils between primary and recurrent CRSwNP. Tissues collected during the primary surgery and 3, 6 and 12 months after the first endoscopic sinus surgery (ESS) procedure were examined histopathologically (recurrence was found in 7 out of 32 patients). Studies showed a positive correlation between all examined histopathological parameters and tissue eosinophils and the number of peripheral blood eosinophils. In revision surgery, only the thickness of the basement membrane positively correlated with tissue eosinophilia and goblet cell hyperplasia. Recurrent CRSwNP showed a positive correlation between tissue eosinophilia and peripheral blood eosinophils, however, the mean number of tissue eosinophils was significantly lower than during the primary procedure.

Subepithelial fibrosis is the result of the deposition of improperly built collagen fibers (including types I, III, V), fibronectin, tenascin, and the accumulation of extracellular matrix components within the basement membrane [21].

Maxfield et al. [22] showed that the serum periostin levels are higher in patients with CRSwNP than in those with CRSsNP and in the control group. On the other hand, no positive correlation was found with: nicotinism, gender, 1-month use of oral steroid therapy, use of nasal steroids, previous rhinological interventions and hypersensitivity to acetylsalicylic acid.

When researching the impact of irritating factors affecting respiratory comfort, most often mentioned by patients were: rapid temperature changes in 60.0% of cases and dry air in 58.0% of cases in group I and 56.0% of cases and 54.0% of cases in group II, while in group III, respectively 30.0% of cases.

Both in group I and II, patients most often reported air pollution as medium and high (smoke and fog), respectively in 42.0% of cases and 42.0% of cases, and in 32.0% of cases and in 30.0% of cases.

36.0% of patients in group I and 22.0% of patients in group II were cigarette smokers, while alcohol was consumed by only 12.0% of patients in group I and 20.0% of patients in group II.

To conclude, it should be stated that chronic paranasal rhinosinusitis with nasal polyps is a disease whose cause is multifactorial (the influence of external and internal irritants, allergic and infectious inflammations, hypersensitivity to acetylsalicylic acid, immune disorders, anatomical anomalies and etc.). However, an important factor affecting typical tissue remodeling in chronic rhinosinusitis with polyps is long-term inhalation of polluted air, which is confirmed by, e.g. the conducted survey.

**CONCLUSIONS**

1. In the studied material, patients with chronic paranasal rhinosinusitis without/with nasal polyps in most cases are in the age range of 51–60 and over 60 years of age; most often they live in large cities over 250 thousand, suffer from allergic rhinitis in 38.0% in group I and 36.0% in group II; rapid temperature changes and dry air have a negative impact on breathing comfort;

2. Stimulants such as smoking and alcohol consumption are not the main reason for the irritating effect on the nasal mucosa, 36.0% of patients in group I and 22.0% of patients in group II, respectively, were smokers, while only 12.0% of patients in group I and 20.0% of patients in group II consumed alcohol;
3. The conducted survey confirms that the cause of chronic rhinosinusitis with polyps is multifactorial, but an important factor affecting typical tissue remodeling in this condition is prolonged inhalation of polluted air.