



## Risk factors for the appearance of minimal pathologic lesions on vocal folds in vocal professionals

### Faktori rizika od nastanka minimalnih patoloških lezija na glasnim žicama vokalnih profesionalaca

Jasmina Stojanović\*, Nevenka Ilić†, Predrag Stanković‡, Snežana Arsenijević\*,  
Ljiljana Erdevički\*, Branislav Belić§, Ljubica Živić\*, Dragić Banković||

\*Clinic for Ear, Nose and Throat, Clinical Centre Kragujevac, Kragujevac, Serbia; †Institute of Public Health, Department of Immunology and Allergology, Kragujevac, Serbia; ‡Institute for Ear, Nose and Throat, Clinical Centre of Serbia, Belgrade, Serbia; §Clinic for Ear, Nose and Throat, Faculty of Medicine, University of Priština, Kosovska Mitrovica, Serbia; ||Faculty of Science, University of Kragujevac, Kragujevac, Serbia

#### Abstract

**Background/Aim.** An excessive use or misuse of voice by vocal professionals may result in symptoms such as husky voice, hoarse voice, total loss of voice, or even organic changes taking place on vocal folds – minimal pathological lesions – MAPLs. The purpose of this study was to identify the type of MAPLs which affects vocal professionals, as well as to identify the risk factors that bring about these changes. **Methods.** There were 94 vocal professionals who were examined altogether, out of whom 46 were affected by MAPLs, whereas 48 of them were diagnosed with no MAPLs, so that they served as the control group. All these patients were clinically examined (anamnesis, clinical examination, bacteriological examination of nose and pharynx, radiography of paranasal cavities, allergological processing, phoniatric examination, endo-video-stroboscopic examination, as well as gastroenterologic examination, and finally endocrinological and pulmonary analyses). **Results.** The changes that occurred most often were identified as nodules (50%;  $n = 23/46$ ) and polyps (24%;  $n = 11/46$ ). Risk factors causing MAPLs in vocal professionals were as follows: age, which reduced the risk by 23.9% [OR 0.861 (0.786–0.942)] whereas the years of career increase the risk [OR 1.114 (1.000–1.241)], as well as the presence of a chronic respiratory disease [OR 7.310 (1.712–31.218)], and the presence of gastro-oesophageal reflux disease [OR 4.542 (1.263–16.334)]. The following factors did not contribute to development of MAPLs in vocal professionals: sex, a place of residence, irritation, smoking, endocrinologic disease and the presence of poly-sinusitis. **Conclusion.** It is necessary to introduce comprehensive procedures for prevention of MAPLs, particularly in high-risk groups. Identification of the risk factors for MAPLs and prevention of their influence on vocal professionals (given that their income depends on their vocal ability) is of the highest importance.

#### Key words:

vocal cords; occupational exposure; risk factors; polyps.

#### Apstrakt

**Uvod/Cilj.** Prekomerna upotreba ili zloupotreba glasa kod vokalnih profesionalaca može dovesti do pojave simptoma (slabosti glasa, promuklosti i gubitka glasa), kao i do razvoja organskih promena na glasnim žicama (MAPLs – *minimal pathological lesions*). Cilj rada bio je utvrditi vrstu MAPLs kod vokalnih profesionalaca, kao i faktore rizika koji dovode do njihove pojave. **Metode.** Ova prospektivna studija obuhvatila je 94 vokalna profesionalaca i to 46 sa MAPLs i 48 bez MAPLs, koji su činili kontrolnu grupu. Kod svih bolesnika bilo je sprovedeno osnovno kliničko ispitivanje [anamneza, klinički pregled, bakteriološki pregled nosa i ždrele, radiografija paranazalnih šupljina, alergološka obrada, fonijatrijski pregled, endovideostroboskopski pregled (Storz), kao i gastroenterološki pregled, endokrinološka i pulmološka obrada]. **Rezultati.** Najčešće utvrđene promene kod vokalnih profesionalaca bili su: noduli (50%,  $n = 23/46$ ), a zatim polipi (24%,  $n = 11/46$ ). Faktori koji su imali uticaja na pojavu MAPLs kod vokalnih profesionalaca su: godine starosti koje smanjuju rizik za 23,9% [OR 0,861 (0,786–0,942)], dok rizik povećavaju godine staža [OR 1,114 (1,000–1,241)], postojanje hronične respiratorne bolesti [OR 7,310 (1,712–31,218)] i postojanje gastroezofagusne bolesti [OR 4,542 (1,263–16,334)]. Na pojavu MAPLs kod vokalnih profesionalaca nisu imali uticaja pol, mesto življenja, postojanje iritacije, pušenje, endokrinološka bolest, kao i postojanje polisinusitisa. **Zaključak.** Neophodno je uvođenje sveobuhvatnih preventivnih postupaka za sprečavanje nastanka MAPLs, posebno u visokorizičnim grupama. Naročito je važno utvrđivanje faktora rizika od nastanka MAPLs i otklanjanje njihovog uticaja u grupi vokalnih profesionalaca, s obzirom da je njihova sposobnost zarade u negativnoj vezi sa gubitkom kvaliteta glasa.

#### Ključne reči:

glasne žice; profesionalna izloženost; faktori rizika; polipi.

## Introduction

It has been determined that 3%–9% of the population is diagnosed with voice disorder<sup>1</sup>. According to Sataloff et al.<sup>2</sup>, the term “vocal professionals” refers to anyone whose income is likely to be affected by the loss of quality or resilience of their voice. Vocal professionals use their voice to a larger extent, over an extended period of time, in a higher intensity, and within various circumstances including different psycho-physical and microclimatic conditions. There are four widely-accepted levels of voice disorder and voice usage nowadays (Wake Forest University)<sup>3</sup>: level I – minimal voice lesions could have serious professional consequences (opera singers, other types of singers); level II – moderate voice lesions may prevent a vocal professional from carrying out their professional activities (educators, anchors, politicians, receptionists, priests, etc.); level III – serious voice lesions found in non-professionals, which may hinder their professional activities (lawyers, judges, doctors, businessmen); level IV – non-vocal, and non-professional voice usage associated with people whose voice quality is unlikely to affect their professional life (officers, workers).

Two comprehensive studies carried out in the US and Sweden showed that singers are at the highest risk of being affected by disphonia, and then other professionals follow: social workers, teachers, lawyers, priests, telephonists. Teaching profession is of particular socio-medical interest, given the fact that teachers comprised the majority of patients who reported having problems with hoarse voice, which hindered their ability to work and made them take a leave from work<sup>4,5</sup>.

Inadequate vocal techniques may refer to overused voice, or too loud voice (Lombard effect – noisy speech), as well as they may be associated with an inadequate vocal hygiene<sup>6</sup>, which may cause the symptoms of voice pathology to appear (weak voice, hoarse voice, or the loss of voice) or it may result in organic changes on vocal folds<sup>7</sup>. The term of minimal pathological lesions (MAPLs) has been defined so as to denote any changes on vocal folds which do not require primary surgical treatment, but are treated by phoniatic methods to a satisfactory degree<sup>6</sup>. According to Kotby<sup>7</sup>, organic disphonies coming together with MAPLs are identified as follows: polyps, vocal fold knots (juvenile and adult types), Reinke’s edema, contact granuloma, vocal cord cysts and ventricular disphonia with hypertrophy.

The factors which may cause the occurrence of MAPLs, apart from those mentioned above, including voice overuse or vocal traumatism, include thyroid gland dysfunction, allergic diseases of voice activator, generator and resonator, smoking, the existence of chemical and mechanical irritations in working and living environments, alcohol consumption, laryngeal reflux, etc.<sup>8</sup>.

The aim of this study was to identify the type of MAPLs which affect vocal professionals, as well to identify the risk factors that bring about these changes.

## Methods

In a prospective study carried out at the Phoniatics Department of the Institute for Otorhinolaryngology and Maxillofacial Surgery of the Clinical Centre of Serbia in Belgrade, 94 vocal professionals were observed. Out of them 46 were affected by MAPLs, whereas 48 didn’t have MAPLs, so that they were the control group.

All these patients were clinically examined: anamnesis, clinical examination, bacteriological examination of nose and pharynx, radiography of paranasal cavities, allergological processing, phoniatic examination, endo-videostroboscopic examination, as well as gastroenterologic examination, and finally endocrinological and pulmological analyses.

According to Kotby<sup>7</sup>, organic disphonies coming together with MAPLs are identified as the following: polyps, vocal fold knots (juvenile and adult types), Reinke’s edema, contact granuloma, vocal cord cysts, and ventricular disphony (with hypertrophy).

The group with MAPLs included examinees out of whom 21% (n = 20/94) had a job associated with the level I, 52% (n = 49/94) of them were engaged in professional activities belonging to the level II, whereas 27% of them (n = 25/94) had a career associated with the level 3 of voice usage<sup>9</sup>. Patients with MAPLs, befalling to voice usage level IV, were not included in the study.

The observation was carried out in line with ethical standards of the Declaration of Helsinki.

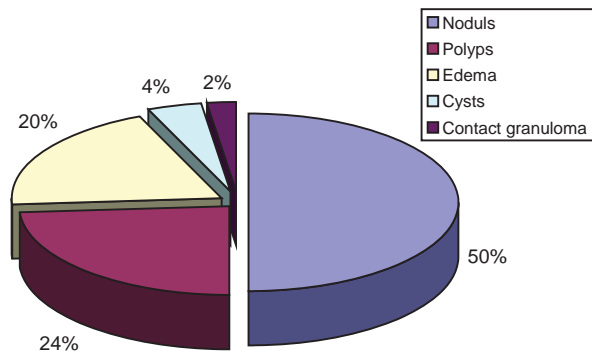
The methods of descriptive statistics were used, Student’s *t*-test and  $\chi^2$  test were used to test the dependability of category variables. ROC curve was used to examine if age could play a role of a marker for MAPLs. Binary logistic regression helped us determine dependability of MAPLs on those variables that the  $\chi^2$  test identified as being associated with MAPLs. The degree of risk was expressed by odds ratio (OR). For statistically important difference we took the difference  $p < 0.05$ .

## Results

The frequency and the type of MAPLs changes in the MAPLs group (n = 46) are presented in the Figure 1. The most frequent changes were found to be nodules (50%, n = 23/46), and polyps (24%, n = 11/46).

In the whole group of examinees it was determined that MAPLs were more frequently found in female vocal professionals (74%, n = 34/46), but it can be observed that, when it comes to sex, there was no statistically important difference in comparison to the control group (70.8%, n = 34/48) ( $p = 0.173$ ).

However, there was a statistically important difference when it comes to the average age of examinees in the MAPLs group and those in the control one. The average age of the patients in the MAPLs group was 39, whereas the average age of the patients in the control group was 47 (39 vs 47,  $p < 0.005$ , cut off = 42.5 years).



**Fig. 1 – The frequency and type of the minimal pathological lesions (MAPLs) in the vocal professionals (the type of MAPLs is expressed in percentages)**

The frequency of MAPLs declines in the patients whose age was over 42.5 (for the cut-off of 42.5 sensitivity equaled 62.5%, while the specificity was 65.7%).

There was a statistically important difference between the MAPLs and the control group in terms of the length of professional career. The patients in the MAPLs group had a shorter career (15 years), while the patients in the control group spent averagely 19 years in office ( $p = 0.022$ ).

In the group of elite vocal professionals with level I it was observed that 50% of the examinees had MAPLs diag-

Chronical obstructive pulmonary diseases statistically correlated with MAPLs ( $p = 0.003$ ). In the MAPLs group, 32.6% ( $n = 15/46$ ) of the examinees were diagnosed with asthma or COPD, while 8% ( $n = 4/48$ ) of the examinees from the control group had the same diagnosis. It was determined that all patients with asthma had MAPLs ( $n = 3/3$ ) and 75% ( $n = 12/16$ ) of them were diagnosed with COPD.

Gastro-oesophageal reflux disease (GERD) proved to be statistically significant for MAPLs found in vocal professionals ( $p = 0.008$ ). GERD was diagnosed in 32% ( $n = 15/46$ ) cases in the observed group, whereas this was the case with 10.4% ( $n = 5/48$ ) of the examinees in the control group.

Nasal swab findings ( $p = 0.380$ ) and radiography and computed tomography scan of paranasal cavities ( $p = 0.539$ ), as well as the endocrine diseases of thyroid gland ( $p = 0.318$ ), were identified as no significant risk factors for MAPLs.

Considering the variables for which  $\chi^2$  test and  $t$ -test showed that they correlated with MAPLs, binary logistic regression helped us prove a mutual interdependance between MAPLs and the following: age ( $p = 0.001$ ), the length of career ( $p = 0.049$ ), chronical respiratory diseases ( $p = 0.007$ ), and gastro-oesophageal reflux disease ( $p = 0.020$ ). The risk values as related to the above-mentioned factors are showed in Table 1.

**Table 1**

**Odds ratio for the occurrence of minimal pathological lesions (MALPs) in relation to the exposition to the observed risk factors**

Risk factors	Odss ratio (OR)	MAPLs risk description
Age (years)	0.861 (0.786 – 0.942)	Each year of age decreases the risk by 23.9%
Years in career	1.114 (1.000 – 1.241)	Each year in career increases the risk by 11.4%
Chronic respiratory diseases	7.310 (1.712 – 31.218)	The existence of chronic respiratory disease increases the risk for MAPLs by 7.3%
Gastro-oesophageal reflux disease	4.542 (1.263 – 16.334)	The presence of gastro-oesophageal reflux disease increases the risk for MAPLs by 4.5%

nosed ( $n = 10/20$ ), whereas 59% of them were diagnosed with MAPLs in the group of professionals associated with the level II changes ( $n = 29/49$ ). The lowest percentage was observed in patients whose career was associated with the level III, where 28% of them were diagnosed with MAPLs ( $n = 7/25$ ). A statistically important difference has been found in terms of different levels of voice usage and their role in generating MAPLs ( $p = 0.040$ ).

In the MAPLs group 19% ( $n = 9/46$ ) of patients were exposed to chemical irritation at work, whereas only 8% of patients in the control group experienced a similar exposure ( $n = 4/48$ ), but a statistically significant difference between the MAPLs and the control group has not been established ( $p = 0.100$ ). In the MAPLs group, smokers (39%,  $n = 18/46$ ) were more frequently found than non-smokers (33%,  $n = 16/48$ ), but this variable was proved to be statistically insignificant ( $p = 0.356$ ).

Our findings show that the following observed risk factors do not correlate with MAPLs: sex, place of residence, the presence of chemical and mechanical irritations, smoking, thyroid gland disfuncion, and the diagnosis of rhinosinuitis.

**Discussion**

Vocal professionals account for about a half of working population. In 30% of them there is a functional disphonia observed, and its long-term presence may result in MAPLs<sup>10</sup>. Morphological changes that are identified to occur most often in vocal professionals are the following: fibrovascular lesions on vocal folds (nodules, polyps), cysts, scars on vocal folds, changes in vocal fold mobility, the presence of laryngopharyngeal reflux and muscle tension dysphonia<sup>11</sup>. In our MAPLs group 70% of vocal profession-

als diagnosed with MAPLs had nodules and polyps. Not all vocal professionals are equally sensitive to vocal trauma, which means that some of them are more likely to develop organic lesions than the others<sup>12</sup>.

Many studies carried out in China, America, Spain, and Slovenia, whose aim was to examine dysphonia and organic lesions on vocal folds in vocal professionals, were based on profession classification according to which one's voice is one's primary working tool<sup>4, 8, 13-15</sup>. Chinese authors pointed out that one's profession may play an important role of risk factor for generation of benign lesions on vocal folds, with a risk being up to 2.6 times higher in professions where one's voice is more extensively used than in those where it is not<sup>8</sup>. Hocevar-Boltazer<sup>15</sup> reported that 85.6% of priests had voice-related problems adding that 15.9% of them had reported health problems related to voice loss to their physician at a regular basis<sup>15</sup>. Miller and Verdolini<sup>16</sup> found that 16% of music (singing) teachers (level I), in the autoanamnesis, reported voice-related problems. Phylant et al<sup>17</sup> reported findings which showed that 44% of singers (level I) had problems with their voice<sup>17</sup>. Smith et al<sup>18</sup> claimed that 32% of teachers (level II) had problems with their voice. Spanish authors carried out a comprehensive study which observed 905 teachers (level II) showing that 57% of them had voice disorder, out of whom 14% were diagnosed with nodules and 2.5% of them with polyps<sup>13, 14</sup>. Our research, also, showed that there was a statistical correlation between one's profession and organic lesions. Half of vocal professionals, who are solo singers, choir singers, actors/actresses (level I) were diagnosed with MAPLs, while on the other hand, there were 59% of examinees who worked as children care professionals, teachers and priests (level II). A high frequency of MAPLs in vocal professionals associated with level II was attributed to lower level of oral hygiene as compared to elite vocal professionals (level I), who got MAPLs due to high vocal demands. A quarter of examinees who were lawyers, judges, doctors, and command staff (level III) displayed MAPLs, as well.

Pérez Fernández and Preciado López<sup>19</sup> pointed out that vocal professionals with a shorter professional life were more likely to develop nodules than their colleagues with a longer career. This comes as a consequence of voice overuse by the young in comparison to the older people, who have been trained in using their voice. This matches our findings, where vocal professionals with MAPLs in the observed group were, at average 8 years younger than the examinees in the control group.

Spanish authors did not identify any statistically significant difference in the presence of dysphonia among examinees of different sex, based on the sample of 300 teachers; but on the extended sample of 905 examinees, they managed to conclude that women are three times more likely to be affected by organic lesions than men<sup>13, 14</sup>. Phylant et al.<sup>17</sup> concluded that sex (female) can pose a risk to voice-related problems (OR = 1.4). According to Preciado et al.<sup>20</sup> one of the reasons why women (19.3%) experience problems with their voice more often than men (15.6%) may be found in a higher number of women performing as vocal professionals.

According to other authors, this may result from women being the ones who visit their doctor more often than men, because they are concerned about their voice more than men are about their own, regardless of whether the problem is related to acute or chronic voice problems<sup>12, 18</sup>. Our research has shown that sex did not influence the occurrence of organic lesions on vocal folds, although women were found to be more susceptible to MAPLs.

Some associated diseases which contribute to disorders in voice production – whether they affect the controlled expirium (which provides for voice activation) or the sufficient glottis occlusion (the level of voice generator) – are listed as risk factors for MAPLs occurrence in literature<sup>21</sup>. Professional singers and other elite vocal professionals are susceptible to alterations of vocal apparatus and pulmonary functions, because the voice activator represents the essential element in production of sound and speech<sup>22</sup>. The presence of asthma or COPD disables the adequate amount of expiratory air flow from leaving lungs, which hinders voice production, as well. Thus, patients suffering from asthma or COPD are more likely to experience dysphonia.

Videostroboscopic findings of asthma-suffering patients, show that there is a reduction in the amplitude of vibrations and reductions in expanding mucus flow, resulting in hyperemia of vocal folds, or the occurrence of changes similar to plaque on vocal folds<sup>23</sup>. Our study shows that vocal professionals with chronic respiratory diseases are 7.3 times more likely to develop MAPLs than vocal professionals with no chronic respiratory diseases. On the other hand, a number of authors point out that it is possible to draw lines between MAPLs in asthma-suffering patients and the therapy they get to cure the disease. For instance, Del Gaudio<sup>24</sup> noticed more frequent occurrence of mucus edema, eritema, and candidiasis on the epiderm of larynx in asthmatic patients whose dysphonia was treated with inhalatory corticosteroids. Dysphonia in these patients disappeared after therapy with inhalatory corticosteroids was discontinued<sup>24</sup>.

Arabian authors noticed that 80% of patients with benign vocal fold lesions were diagnosed with GERD<sup>25</sup>. Makhadom et al.<sup>25</sup> pointed out the influence of gastro-oesophageal reflux disease on the pathogenesis of MAPLs. Kuhn et al.<sup>26</sup> pointed out the influence that GERD may have on the occurrence of nodules on vocal folds. Our results show that one third of vocal professionals diagnosed with MAPLs suffer from GERD, as well. Our tests showed that vocal professionals diagnosed with GERD were 4.5 times more likely to develop MAPLs, as opposed to the patients not been diagnosed with GERD. Given the influence of gastro-oesophageal reflux disease on the occurrence of MAPLs, there are numerous authors who emphasize the need for pulmonologists, allergologists, and ORL specialists, and other physicians who treat chronic cough or asthma non-responsive to the therapy (uncontrolled asthma), to be familiar with diagnosis and treatment of these diseases, in order to provide efficient treatment to their patients<sup>27</sup>.

Among the vocal professionals whose working ability is negatively affected by their voice-related problems, there is a more frequent decline in self-esteem and self-confidence, as

well as moodiness due to dysphonia. For this reason, it is necessary to take a more comprehensive approach to examining voice in vocal professionals, which would be directed towards individuals so as to include the following: a phoniatic examinations of individuals who want to start a career of a vocal professional (systematic examinations of schoolchildren and students, as well as the young individuals who seek employment, etc); education of vocal professionals providing advice on voice hygiene (proper usage of their voice); identification and removal of a wide spectrum of additionally listed risk factors which may result in MAPLs, such as: noise level, classroom size, the number of workload hours in class,

the presence of air dryness and dust at the place of work; development of general and individual protocols in treating dysphonia and MAPLs in vocal professionals.

### Conclusion

It is necessary to introduce comprehensive procedures for prevention of MAPLs, particularly in high-risk groups. Identification of the risk factors for MAPLs and prevention of their influence on vocal professionals (given that their income depends on their vocal ability) is of the highest importance.

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