

Vocal Symptoms and Voice Quality in Children With Allergy and Asthma

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Summary: Objectives. The background for dysphonia is multifactorial, and health-related factors have been listed among the factors affecting voice. In previous studies with adult participants, allergy and asthma have been indicated to have a connection to vocal symptoms. With the majority of previous research being studies involving adult participants, it is unclear what the effect of allergy and asthma on children's voices is. The aim of this study was to investigate if allergies and asthma are risk factors for having vocal symptoms.

Methods. The material was collected through paper questionnaires distributed to the parents of new pediatric patients at an allergy clinic. The participants were 108 children aged 9 months to 17 years and 1 month.

Results. Of the children whose parents had filled in the questions on vocal symptoms, 18.2% ($n = 18$) had frequently occurring vocal symptoms, which was defined as having two or more vocal symptoms every week or more often. The most common vocal symptoms were throat clearing and coughing. There was a significant connection between inhalant allergy and having frequently occurring vocal symptoms. The connection between cough that lasted for more than 4 weeks and having frequently occurring vocal symptoms was also significant. In this study, we found no significant connection between having an asthma diagnosis and having frequently occurring vocal symptoms.

Conclusions. Based on the results of this study, voice screening for children with inhalant allergy would be advisable. Prolonged cough should be taken seriously and be treated, as the mechanical trauma caused by cough seems to have a connection to vocal symptoms.

Key Words: Vocal symptoms—Children—Asthma—Inhalant allergy—Cough.

BACKGROUND

In studies from the past decades, dysphonia in children has been estimated to be present in 0.12%¹ to 23.9%.² The background of dysphonia is multifactorial, and in previous studies health-related factors,^{3–5} personality traits,^{6–8} and environmental factors^{9–12} have been suggested to influence voice quality. In this study, the main focus will be on allergies and asthma as potential background factors for vocal symptoms in children.

According to Krouse et al,¹³ the upper and lower airways are increasingly being viewed as an integrated system. If one part is affected by inflammation, it is likely that this has an impact on the whole system.¹⁴ Allergy- and asthma-related vocal symptoms are principally being viewed as secondary to another disease process, eg, allergic rhinitis or asthma, but preliminary results have suggested that there could be a direct causal effect of allergen exposure to dysphonia.¹⁴ For example, the results of a study by Dworkin et al¹⁵ indicated that allergen provocation of the larynx may lead to viscous secretions in the larynx, vocal fold edema and erythema, coughing, throat clearing, and hoarseness in persons with perennial dust mite allergy.

In previous studies with adult participants, allergy has been indicated to have a connection to vocal symptoms. In one study,⁵ young adult participants with allergy reported significantly more

vocal symptoms than participants without allergy. In another study, more persons with pollen allergy than controls experienced vocal symptoms during and between pollen seasons.¹⁶ There was also an increase of vocal symptoms during the pollen season and a decrease during the non-pollen season. The allergic group also had more throat infections.¹⁶

Allergic laryngitis can be caused by inhalant allergies and be manifested as vocal fold edema.¹⁷ Allergens that are typically tested during screening for inhalant allergy are pollens, mold, dust mites, animal dander, and cockroach.¹⁸ A definition of inhalant allergy used in a previous study¹⁹ was being allergic to one or more of the allergens cat, pollen, and dust. The results of the study by Millqvist et al²⁰ also showed that persons allergic to birch pollen were significantly more hoarse during the pollen season than the control group. Persons with allergy have also been reported to have a higher degree of vocal dysfunction measured with Voice Handicap Index than persons without allergy.^{20,21} Asthma and allergy, but not eczema, have been reported to be significantly related to the frequency of upper respiratory tract infections.²² Food allergy is defined as an abnormal immune response to food proteins,²³ and the prevalence of self-reported food allergy in children has been estimated to be 6.86% in Europe²⁴ and 8% in the United States.²⁵ Depending on geographic location, the frequency of different food allergies is different.²³ In a study by Dixon,²⁶ food antigen provocation tests resulted in dysphonia due to thick mucus production and an irregular glottic edge edema.

Asthma is defined by Akinbami et al²⁷ as “a chronic respiratory disease characterized by episodes or attacks of impaired breathing.” The symptoms of asthma are cough, wheezing, shortness of breath, chest tightness, and sputum production, usually varying during the day and worsening during the night.²⁸ The results of a study by Dogan et al³ showed that persons with asthma scored significantly higher on the voice quality parameters grade,

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roughness, and breathiness compared with the control group. Additionally, they had shorter maximum phonation times. Some medicines that are used for treating respiratory symptoms, such as inhaled corticosteroids, can also have a negative effect on voice quality.^{29–31}

If children with allergy or asthma have more vocal symptoms than children in normal populations, this could be valuable information when planning the treatment of both the vocal symptoms and the allergy or asthma. The treatment of vocal symptoms should, if possible, be directed at both the underlying cause and the manifested symptoms. If there is a connection between vocal symptoms and allergy or asthma, voice screening for children with allergy or asthma could be recommendable. The aim of this study was to investigate if allergies and asthma are risk factors for vocal symptoms.

METHODS

The material for this study was collected through paper questionnaires distributed to the parents of new pediatric patients at the allergy clinic at Turku University Hospital from 2013 to 2015. An overview of the questionnaire is presented in Table 1. Validated pediatric voice questionnaires were not available in Finnish, and therefore questions that had been used in previous research were used instead.^{32–34}

The children who visited the allergy clinic were referred there from health centers when their allergy or asthma could not be successfully treated by a general practitioner or when more extensive examinations were needed. In all children, allergy was confirmed with specific IgE assays and asthma was confirmed with spirometry (over 6 years of age) or oscillometry (3–6 years of age) combined with exercise challenge or bronchodilatation. In younger children, the asthma diagnosis was clinical and based on a therapeutic trial. Due to the sample population being small, children of all ages were included in the study.

The variable inhalant allergy was composed of the answers to the questions on asthma symptoms or rhinitis and/or eye symptoms from dust, animals, and pollen. If the parents reported asthma symptoms or rhinitis and/or eye symptoms from one of the three allergen groups, the child was coded as having inhalant allergy. Dust mites and mold are usually also regarded as allergens in inhalant allergy,¹⁸ but because there were no specific questions on reactions to dust mites and mold in the questionnaire, these were not included. Children who had two or more vocal symptoms occurring every week or more often were defined as having frequently occurring vocal symptoms.

Permission for using the data for this study was granted by the Hospital District of Southwest Finland (TO5/041/14), and a notification of data use was sent to the data protection ombudsman (2518/4225/14).

Non-parametric tests were used for data analysis. For correlation analyses, Spearman's correlation coefficient was reported. When exploring the connection between binary and continuous answers, the Mann-Whitney *U* test was used and the two-tailed exact significance value was reported. For questions with two answer alternatives for both variables, the Pearson's chi-square test was used. Valid percents were reported.

RESULTS

Fifteen participants were excluded from the study due to missing information on both vocal symptoms and voice quality, one participant due to having a non-specified developmental disorder and four participants because their parents had explicitly indicated in the questionnaire that their children were going through voice mutation. The remaining participants were 108 children aged 9 months to 17 years and 1 month (mean age: 8 years and 4 months). Of the children, 40.7% (*n* = 44) were girls and 59.3% (*n* = 64) were boys. The living environment of the children was 5.6% (*n* = 6) city environment, 52.3% (*n* = 56) small town or suburb, and 42.1% (*n* = 45) countryside. Information on living environment was missing for one participant.

The parents of 94 children rated their children's current voice quality on the visual analog scale (VAS) and 99 filled in the questions on vocal symptoms. The parents of 85 children did both. The mean value on the voice quality scale for the whole group was 18.3 mm (standard deviation [*SD*] = 22). The mean value for girls was 19.1 mm (*SD* = 24.3) and the mean value for boys was 17.7 mm (*SD* = 20.3).

Of the participating children whose parents had filled in the questions on vocal symptoms, 18.2% (*n* = 18) were reported to have frequently occurring vocal symptoms. Of these, seven were girls (17.1% of all girls) and eleven were boys (19% of all boys). Of the participants, 12.1% (*n* = 12) were reported to have one vocal symptom every week or more often, and 69.7% (*n* = 69) were reported to have no vocal symptoms. Throat clearing and coughing were the most common vocal symptoms and were prevalent in 26.5% of the participants (Table 2).

Frequently occurring vocal symptoms had a significant connection to the voice quality ratings on the VAS scale (*U* = 202, *z* = −3.953, *P* = 0.000). For those who had frequently occurring vocal symptoms (*n* = 16), the voice quality rating mean was 39.4 mm (*SD* = 25.9), and for those with more rarely occurring symptoms or no symptoms (*n* = 69) the voice quality mean was 12.7 mm (*SD* = 17.7). There was no significant connection between gender and frequently occurring vocal symptoms (χ^2 [1] = 0.058, *P* = 0.810), and between age and frequently occurring vocal symptoms (*U* = 535, *z* = −1.76, *P* = 0.078).

Of the children, 48.1% (*n* = 52) had inhalant allergy, and 49 of these children's parents filled in information regarding vocal symptoms. Of them, 28.6% (*n* = 14) had frequently occurring vocal symptoms. The corresponding number for children without inhalant allergy was 8% (*n* = 4). The connection between inhalant allergy and frequently occurring vocal symptoms was significant (χ^2 [1] = 7.04, *P* = 0.008).

Current or previous food allergy was reported in 67.3% (*n* = 66) of the children. Regarding the question on other symptoms of food allergy, the parents of two children reported that their child experienced hoarseness, although there was no significant connection between food allergy and frequently occurring vocal symptoms (χ^2 [1] = 0.001, *P* = 0.979).

The prevalence of diagnosed asthma among the participating children was 19.2% (*n* = 20). Twelve of them were girls (29.3% of all the girls) and eight were boys (12.7% of the boys), and there was a significant association between female gender and having an asthma diagnosis (χ^2 [1] = 4.39, *P* = 0.036). There

TABLE 1.
Overview of the Questions From the Questionnaire Used in This Study

Allergy	Allergy symptoms in the family (mother, father, and siblings) Age of onset of rhinitis and/or eye symptoms, the type of symptoms, and when they occurred Food allergy (open questions where the parents were asked to list previous and present food allergies and the symptoms of the food allergy); the parents were also asked to indicate yes or no for stomach and gut symptoms, skin symptoms, and/or other symptoms, and to specify what these other symptoms were.
Eczema*	Yes/No
Environment	How many adults and children there are at home Smoking habits in the family Where the child is spending his or her days (day care or school) Animal contact at home or elsewhere Type of home, how many rooms there are in the home, if the child has a bedroom of his/her own How long the family has lived in the current home If there has been moisture or mold damage in the home If the child sleeps in the parents' bed The type of area where the home is situated Occurrence of the following in the child's room, other room, or at home, or the school/day care: Wall-to-wall carpeting Long-pile rugs Riding clothes Potted plants
General health	Presence of factories, farms, or heavy traffic close to the home Diseases and disorders Regular medication Hospitalizations Surgical interventions in the pharynx and ears Airway infections Stomach and gut problems Snoring Occurrence of prolonged cough (more than 4 weeks) Night or morning cough (and age when the cough started) Gastroesophageal reflux disease
Asthma or cough symptoms	Asthma diagnosis Exhalation problems or wheezing during the last 12 months and/or during the whole life and how many of these had been confirmed by a doctor Seasonal variation of symptoms Increase or decrease of symptoms during the previous year Interference with the child's ability to participate in school gymnastics How many days during the last 4 weeks the symptoms had occurred (not at all, 1–3 days, 4–10 days, 11–18 days, 19 days or more)
Temperament	Personality traits (100 mm VA scale)
Voice	Vocal symptoms (the frequency of the listed vocal symptom: daily, weekly, more rarely, or not at all) Current voice quality (100 mm VA scale, marked completely clear to the left = 0 mm, and very hoarse to the right = 100 mm) Occurrence of changes on the vocal folds

In addition to these, the triggers of asthma, rhinitis, and/or eye symptoms, eczema, and other symptoms were listed in a chart, and the parents were asked to tick those that triggered symptoms in their children.

* There were several questions on eczema in the questionnaire, but they were not included in detail in the data analysis. Only the presence or absence of eczema was entered in the data matrix.

was no significant connection between having an asthma diagnosis and having frequently occurring vocal symptoms (Table 3).

Of the participating children, 51.2% ($n = 44$) used asthma medicine on an occasional or regular basis. The most commonly used medicine was Ventoline (38%, $n = 41$). Inhaled corticosteroids (Flixotide or Symbicort) were used by 10.2% ($n = 11$). There

was no significant connection between using Ventoline ($\chi^2 [1] = 0.005$, $P = 0.941$) or inhaled corticosteroid (Fisher's exact test, $P = 0.687$) and having frequently occurring vocal symptoms.

Having had cough that lasted for more than 4 weeks had a significant connection to frequently occurring vocal symptoms ($\chi^2 [1] = 6.257$, $P = 0.012$). Of the children, 30.5% ($n = 32$) have

TABLE 2.
Prevalence of the Different Vocal Symptoms

Vocal Symptom	Every Week or More Often	More Rarely/Not at All
Throat clearing and coughing (<i>N</i> = 98)	26.5% (<i>n</i> = 26)	73.5% (<i>n</i> = 72)
Voice becomes strained or tires (<i>N</i> = 96)	9.3% (<i>n</i> = 9)	90.6% (<i>n</i> = 87)
Voice becomes low or hoarse (<i>N</i> = 95)	7.4% (<i>n</i> = 7)	92.7% (<i>n</i> = 88)
Sensation of pain, tension, or lump in the throat (<i>N</i> = 89)	12.3% (<i>n</i> = 11)	87.6% (<i>n</i> = 78)
Difficulty in being heard (<i>N</i> = 96)	3.1% (<i>n</i> = 3)	96.9% (<i>n</i> = 93)
Voice breaks and loss of voice (<i>N</i> = 96)	4.2% (<i>n</i> = 4)	95.8% (<i>n</i> = 92)

Note: One participant might have several vocal symptoms and thus be counted several times in Table 2.

TABLE 3.
Prevalence of Different Health Symptoms and Diagnoses and Their Connection to Frequently Occurring Vocal Symptoms

Health Symptoms	Yes	χ^2	<i>df</i>	<i>P</i>
Diagnosed asthma	19.2% (<i>n</i> = 20)			0.750*
Parent-reported wheezing	44.1% (<i>n</i> = 45)	1.951	1	0.162
Eczema	82.7% (<i>n</i> = 62)			0.344*
Food allergy	67.3% (<i>n</i> = 66)	0.001	1	0.979
Laryngitis (more than once)	30.5% (<i>n</i> = 32)	1.751	1	0.186
Eye symptoms (redness, itching, swelling)	46.4 (<i>n</i> = 45)	1.886	1	0.170
"Runny nose"	46.9% (<i>n</i> = 45)	.026	1	0.873
Nasal congestion	61.1% (<i>n</i> = 55)	1.173	1	0.279
Nasal itching/sneezing	48.5% (<i>n</i> = 47)	1.345	1	0.246
Gastroesophageal reflux disease	5.3% (<i>n</i> = 5)			0.223*

* The results of Fisher's exact test are reported due to the estimated counts of one or more cell being less than 5.

had laryngitis more than once, but there was no significant connection to frequently occurring vocal symptoms ($\chi^2 [1] = 1.751$, $P = 0.186$). In this population, heavy voice use as an infant did not correlate significantly with frequently occurring vocal symptoms ($U = 555.5$, $z = -1.09$, $P = 0.276$).

DISCUSSION

In this study, more children had frequently occurring vocal symptoms (18.2%) than in a previous study with a normal population of children (6%).³² The results of this study are similar to the results of two studies with university students, where 17% had frequently occurring vocal symptoms.^{33,34} The difference between these two studies and the present study is that the university students themselves reported the vocal symptoms, whereas in the present study the parents were the ones who reported the symptoms of the children. In previous research, having frequently occurring vocal symptoms has been shown to have a connection to the occurrence of visible changes in the larynx³⁵ and been used as one definition of having a voice disorder.^{5,33,34,36} In this study, having frequently occurring vocal symptoms had a significant connection to the voice quality ratings on a VAS scale, and those who had frequently occurring vocal symptoms had a voice quality rating mean of 39.4 mm. This is in line with a previous study where young adults who had scored 35 mm or more on a VAS scale during screening reported significantly more frequently occurring vocal symptoms.³⁷

In this study, boys and girls had frequently occurring vocal symptoms in similar proportions (19% of the boys, 17.1% of the girls), and there was no significant association between gender and frequently occurring vocal symptoms. The VAS mean values (19.1 mm [$SD = 24.3$] for girls and 17.7 mm [$SD = 20.3$] for boys) were also similar. This is in contrast to the results of a previous study⁸ where male gender was a factor significantly associated with hoarseness, as well as the results of a previous prevalence study in a normal population of children³² where more boys (7.9%) than girls (3.9%) experienced frequently occurring vocal symptoms. Possible gender differences in this population could have been leveled out by the fact that all participants in this study had a more severe type of allergy and asthma that were difficult to manage or examine.

Throat clearing and coughing were the most common symptoms both in this study and in a previously investigated normal population of children.³² It was though prevalent in more children in this study (26.5%) than in the normal population (11.5%).³² The vocal symptoms "voice becomes strained or tires," "sensation of pain, tension or lump in the throat," and "difficulty in being heard" are hard to distinguish for parents because they describe the subjective experience of the speaker which in this case is the child. It is therefore possible that these symptoms have been underreported by the parents. It is also probable that the parents underreported vocal symptoms in their children because they might have become accustomed to how their children sound and ceased to consider what they hear as deviant.

The results showed that 28.6% of the children with inhalant allergy had frequently occurring vocal symptoms. This is lower than in a previous pilot study where 39% of the young adult allergic participants had frequently occurring vocal symptoms.⁵ When comparing the children with and without inhalant allergy, the results showed that significantly more children with inhalant allergy had frequently occurring vocal symptoms. In the present study, the variable inhalant allergy was composed of parent reports of the child having asthma symptoms or rhinitis and/or eye symptoms from one or more of the allergens dust, animals, and pollen. Being allergic to one or more of the allergens cat, pollen, and dust was the definition used by Strachan et al.¹⁹ The method used was similar to the method in the present study: the participants were asked if they were allergic to any of the listed allergens.¹⁹ Other researchers have defined and identified inhalant allergy in different ways. For example, Zutavern et al.³⁸ used screening for specific IgE antibodies against the inhalant allergens timothy, rye, birch, mugwort, house dust mite, cat, dog, and molds, whereas Sugnanam et al.³⁹ used skin prick tests for house dust mite, cat, dog, feather, cockroach, grass mix, tree mix, and the mold *Alternaria*. This is necessary to keep in mind when comparing our results with the results of other studies.

Two parents reported that their children experienced hoarseness as a symptom of food allergy, but having food allergy did not have a significant connection to hoarseness. It is possible that hoarseness is a less common symptom of food allergy, and that when it occurs it is an acute symptom that does not affect the voice quality on a long-term basis. Additionally, if a child is allergic to certain food matters, it is standard procedure to avoid them, leading to a limitation of the allergy symptoms. In this study, 67.3% of the participants had current or previous food allergy compared with about 7–8% reported in previous studies.^{24,25}

In this study, there was no significant connection between having an asthma diagnosis and having frequently occurring vocal symptoms. This is in contrast to the results of a previous study with adult participants where the participants with asthma scored significantly higher on three voice quality parameters than the control group.³ This difference could in part be due to the differences in methodology used in the studies. The medications used by the participants in this study to treat asthma did not have a significant connection to frequently occurring vocal symptoms. The asthma medicine Ventoline was commonly used, and the absence of a significant connection to vocal symptoms could be expected based on the consumer information for Ventoline where no voice-related side effects are mentioned. On the other hand, the consumer information for both Flixotide and Symbicort lists hoarseness as a common side effect (in up to one in ten users).

In this study, 44.1% of the children had experienced wheezing compared with 17.4% in a general population of children.⁴⁰ Because the children in this study had severe allergy or asthma, this was not a surprising result. In the present study, there were significantly more girls than boys having asthma. This is in contrast to previous studies where asthma was more common among boys.^{27,41,42} This could have something to do with who was referred to the asthma and allergy clinic. Because their asthma or allergy was severe or difficult to manage, it is possible that they

were less representative for the whole population of children with asthma or allergy.

The results of this study showed that significantly more children who have had prolonged cough experienced frequently occurring vocal symptoms. This is in line with the results of a previous study⁴ where dry cough, phlegm cough, and nasal congestion were significant predictors for being hoarse every week or more often. The repeated laryngeal trauma caused by the cough seems to be connected to vocal symptoms, and based on this it would be advisable to take cough seriously and offer treatment, especially to those who experience prolonged cough.

The questionnaire was designed to be used for clinical purposes at the allergy clinic and not in all aspects optimal for research purposes regarding response alternatives and construction. For example, some parents had completely skipped some parts of the questionnaire, probably due to those questions not being related to the cause of their visit to the allergy clinic. Further, some questions were possible to interpret in different ways, which in turn had an effect on the answers. When entering data into IBM SPSS Statistics 20 (Armonk, New York), this was taken into account with an extension of the answer alternatives being entered, as well as avoiding the use of certain questions due to the varying responses.

The connection between age and frequently occurring vocal symptoms was not significant ($P = 0.078$), but indicated a slight tendency of age having an impact. Because of the limited number of participants available, participants who based on their age possibly were going through voice mutation were included in the study. Children whose parents had explicitly stated that their children were going through voice mutation had been excluded from the study, with the intention of alleviating the effect of voice mutation on the results. In this study, one child under the age of 1 was included in the study population. Although not common, there has been some previous research where parents have been asked about their young children's voices⁴³ and where very young children's voices have been perceptually evaluated.⁴⁴

Based on the results of this study, voice screening for children with inhalant allergy would be advisable and prolonged cough should be treated. The age span of the participants in this study was wide due to the method of data collection. Future research into the connection between allergy, asthma, and voice would preferably include only prepubertal participants but with all degrees of asthma and allergy. This would yield a more refined insight into how allergy and asthma impact the voice.

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