A Prediction Model for Benign Laryngeal Disease Using RBF Artificial Neural Network

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Abstract. The aim of the present study was to develop a prediction model for benign laryngeal disease. This study analyzed 8,713 adults over the age of 19 who completed laryngoscopic assessment of 2010-2012 Korea National Health and Nutrition Examination Survey (KNHNES). As the result of RBF artificial neural network algorithm, self-reported voice problem, educational level, income and smoking were significant risk factors of benign laryngeal disease (p<0.05). Construction of prevention model is required to be constructed based on this model to minimize the risks of benign laryngeal disease in Koreans.

Keywords: Prediction model, Benign laryngeal disease, Machine learning

1 Introduction

Benign vocal fold mucosal disorders such as vocal nodules, laryngeal polyps, intracordal cysts, Reinke’s edema, laryngeal granuloma, glottic sulcus, and laryngeal keratosis are gathered together under the generic term “benign vocal fold mucosal disorders,” which refers to benign tissues in the laryngeal mucosa, and are typical reasons for dysphonia [1]. Benign vocal fold mucosal disorder is known to cause breathy or rough voice problems by changing mucous membrane and tissues of vocal fold [2].

Although such benign vocal fold mucosal disorders as vocal nodules and laryngeal polyps are voice disorders most frequently contracted by adults, so far studies on risk factors for benign vocal fold mucosal disorders in Koreans have been insufficient.

Prevention and rehabilitation as well as operation are very important for voice disorders. According to Cohen [3], recurrence rate of dysphonia is 73.3% and it has been reported that even after medical treatment may succeed, its recurrence rate is very high. Hence, successful rehabilitation and prevention of dysphonia requires precise identification of risk factors and constant management.

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Meanwhile, machine learning is an algorithm to classify and predict target vector using artificial intelligence. In particular, supervised learning which predicts target vector from the training set has the advantages of effectively solving problems in the future in performing similar tasks based on the experience acquired from inference process and of having high prediction power in figuring out complex risk factors such as voice problems [4].

The aim of the present study was to developed prediction model for benign laryngeal disease.

2 Methods

2.1 Data source

This study analyzed 8,713 adults over the age of 19 who completed laryngoscopic assessment of 2010-2012 Korea National Health and Nutrition Examination Survey [5]. Stratified multistage probability sampling design was adopted based on region, gender, age in the population of registered residents of 2009 and a total of 11,500 samples were surveyed.

2.2 Measurements

The explanatory variables were age, gender, educational level, occupation, income, smoking, binge drinking, smoking, and self-reported voice problems.

Benign laryngeal disease in this study were defined as vocal nodules, laryngeal polyps, intracordial cysts, Reinke’s edema, laryngeal granuloma, glottic sulcus and laryngeal keratosis [6].

2.3 Artificial neural network

In the application of artificial neural network, it is more important than anything else to perform generalized learning so that learned artificial neural network can perform reliable reasoning on the data unused for learning, not the 'learning' itself which is minimizing the value of objective function for given learning data [7], because learned artificial neural network does not have any meaning at all if the learned artificial neural network performs reasoning on the data unused for learning which is different from the pattern inherent in the (parent) population of learning data even when learning is performed on the given learning data while converging on the miniscule value of objective function.

This study used RBF artificial neural network which uses Radial Basis Function (RBF) for combination function of hidden layer.
3  Results

3.1  Characteristics of subjects

Average age of the subjects were 50.3 (standard deviation=16.6). There were more women (56.3%) than men (43.7%) and, as for education level, high school graduates and over (33.05%) and, occupation-wise, economically inactive population (41.4%) were the greatest in number. 58% of the subjects were non-smokers and 72% were drinkers who drink more than once a month. Out of total 8,713 subjects, prevalence rate of benign laryngeal disease was 2.6% (n=230).

3.2. Neural network analysis

As the result of RBF artificial neural network analysis on 59.2% of training sample, 30.8% of test sample and 10.0% of verification sample, 5 hidden layers were drawn out which produce smallest data errors, and sum of square error was 2.7% and, for classification accuracy, training sample proved to be 97.3%, test sample to be 97.2% and verification sample to be 97.3%.

Synaptic weighted network diagram of neural network model is presented in Fig 1. Synaptic weighted value in network diagram demonstrates the relationship among layers and the higher the combined weighted value, the thicker the line between layers. In this model, age, gender, educational level, occupation, income, and smoking were drawn out as major variables with high weighted values of benign laryngeal disease.

![Synaptic weighted network diagram](image)

Fig. 1. Synaptic weighted network diagram
4 Conclusions

In this study, self-reported voice problem, educational level, income and smoking were significant risk factors of benign laryngeal disease.

References