CAUSES AND CONSEQUENCES OF VOICE DISORDERS AMONG TEACHERS

OORZAKEN EN GEVOLGEN VAN STEMKLACHTEN ONDER LERAREN

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TABLE OF CONTE

TABLE OF CONTE

ENTS

ENTS

Chapter 1

INTRODUCTION

BACKGROUND

Voice Disorders as a problem among teachers

About one third of the labour force works in professions in which the voice is their primary tool [1]. Excessive use or abuse of the voice at work may lead to voice disorders [2]. Some studies suggest that workers, whose professions are vocally demanding, such as teachers, may be at greater risk for developing voice disorders [2-8]. Moreover, teachers represent the largest group of professionals who use their voice as a primary job tool [9-11]. Some authors have concluded that the occurrence of voice disorders in teachers has not been well described [2,3]. A large variation in reported prevalence of voice disorders has been observed, ranging from 9% [10] to 94% [9]. Therefore, the occurrence of voice disorders among teachers is still undetermined.

Furthermore, there are no studies that present an estimate of the incidence of voice disorders. Longitudinal studies are required to get more insight into the development of voice disorders among teachers.

Objective vs. subjective measurements of voice disorders

Occupational voice assessment based on self-reports has been used widely as an instrument because voice users are the best experts on their own voices [12]. Perceptual assessment by experts is often considered as the gold standard in voice assessment, because voice is mainly a perceptual phenomenon [13,14]. However, some criticism to the perceptual assessment is the subjectivity of the rating because judgements could depend on internal standards and on interpretation of symptoms such as hoarseness [15,16]. On the other hand, objective assessment (i.e. acoustic analysis) could be helpful in differential diagnosis (functional vs. organic dysphonia). Objective assessments are more comparable and less dependent of internal standards of experts [13]. 'However, the correct computation of some measures of fluctuations, such as jitter, is very sensitive in the presence of highly disturbed voice signals [16]. Nowadays, opinions about the agreement between subjective and objective parameters of voice assessment differ widely [17]. Some studies did show a relationship between self-perceived voice disorders and clinical or acoustic measurements [13,18,19], but other studies have not shown this relationship [20,21]. Up to date, most of those studies have a small sample size, and none of these studies has compared self-reported voice disorders with subjective voice quality assessment as well as objective measurements of voice disorders.

Insight into the relationships between self-reports, perceptual assessment and objective measures would provide relevant information to design protocols to assess voice disorders at work.

Work-related factors of voice disorders

Previous research has identified several work-related factors of voice disorders among teachers, such as noise, class size, dust, ventilation, working schedule, and voice use for long periods without much time to recover [22,23]. In noisy environments, teachers often have to talk loudly for long periods to maintain the attention of the students, and, as a consequence, voice disorders may appear. Moreover, several studies show that teachers who reported poor acoustic and noise conditions in schools or classrooms also reported a higher prevalence of voice disorders than teachers who did not report such conditions [24-26]. In addition, poor ventilation and temperature conditions in the classrooms may interfere with pharyngeal and laryngeal mucosa hydration, increasing difficulties in voice production [12,24,26-28]. Although many studies have indicated that voice disorders among teachers are associated with working conditions, there is a clear lack of consensus about which working conditions are associated with the development of voice disorders in this occupation due to methodological limitations that restrict the conclusions that can be drawn [3]. First, there are almost no longitudinal studies and the evidence presented is primarily based on cross-sectional associations. Second, only a limited number of studies on voice disorders among teachers have clearly defined variables that may be used as reasonable proxies for working conditions. Third, only a small number of studies have used control groups or appropriate data analysis. Fourth, to our knowledge, none of the studies used objective measurements to complement the questionnaire information about physical aspects, such as reverberation time or background noise levels.

In order to establish the work-relatedness of voice disorders among teachers, longitudinal studies are needed to characterize the relative importance of individual and work-related factors in the development of voice disorders among teachers [28].

Consequences of voice disorders

The occurrence of voice disorders among teachers may have several consequences. Studies that have investigated psychosocial consequences show that teachers with voice disorders reported a lower quality of life and reduced daily participation in comparison with non-teachers and teachers without voice disorders [6,17,29,30]. Previous studies showed correlations between restriction in participation (emotions, social life, perception of pressure on their job, and communication) and voice disorders [30,31]. Regarding economic consequences, one study reported that teachers sought (para) medical help in case of voice disorders more frequently than non-teachers [9]. Moreover, teachers were absent from work due to voice disorders more often than employees in other occupations [6,8,9]. However, there is a lack of studies on the socio-economic consequences of voice disorders among teachers. In addition, there is a dearth of studies about the costs of voice disorders among teachers.

Longitudinal studies are required to get more insight into the consequences of voice disorders for functioning and work performance among teachers.

AIMS

Previous studies have shown an association between teaching and voice disorders. Research is needed to get a more accurate approximation of the occurrence of voice disorders in teachers, as well as nature and severity of voice complaints and its socio-economic consequences. The analysis of these aspects is an important issue for the description of the burden of voice disorders among teachers.

Some studies have identified an association between type of employment and self-reported voice disorders. Several studies have shown that teachers are more likely to report voice disorders than non-teachers are [6,7,32,33]. In fact, teachers represent the largest group of professionals who use their voice as a primary job tool [2,3,11]. Therefore, the first objective of this thesis is:

1. To assess the presence of voice disorders among teachers

Perceptual evaluation of voice quality by trained listeners, acoustic measurements and self-assessment voice surveys offer different point of views on describing voice quality [12,18]. Previous studies have suggested including at least three different approaches to assess voice disorders in clinical settings: Perceptual rating of voice quality, acoustics measurement of speech signal, and subjective rating by patients [14,34]. Early identification of voice disorders at work could be helpful to prevent chronic and severe voice disorders among voice professionals. Therefore, the second objective of this thesis is:

2. To evaluate the agreement between different methods of assessment of voice disorders among teachers

Working conditions in teaching, such as noise, class size, dust, and ventilation may contribute to a high prevalence of voice disorders among teachers [22,26]. The relative contribution of work-related factors to the occurrence of voice disorders among teachers is largely unknown. Therefore, the third objective of this thesis is:

3. To distinguish work-related determinants of voice disorders among teachers

Previous studies show that teachers who reported voice disorders felt more restrictions in their participation and a reduced quality of life [9,29,35,36]. In addition, one study showed that teachers were more likely to miss work days due to voice disorders, leading to economic losses for individual teachers as well as their employers [37]. Economic analysis of the direct costs (health services consumption) and indirect costs (due to

disability, sickness absence, loss of long-term earning capabilities among workers, and productivity loss at work) of the disease is an important input for health decision-making and planning processes [38,39]. Therefore, the fourth objective of this thesis is:

4. To identify the socio-economic consequences of voice disorders among teachers

DATA-COLLECTION PROCEDURE

Study design and population

Most articles of this thesis were based on a cross-sectional study and an eleven-months-follow-up study. The cross-sectional study took place at the start of the school year, and the follow-up took place at the end of the school year. These studies were conducted to assess the presence of voice disorders among teachers, to determine work-related factors, and to assess the consequences of voice disorders in teaching. Participants were Colombian school workers (teachers and non-teachers) from 12 public schools in Bogota. Two instruments were used to collect individual data: The "Questionnaire on voice disorders" and a recording of a voice sample. Three instruments were used to collect environmental data by objective and subjective techniques: The "Questionnaire on voice disorders", a walk-through survey with the "Checklist for indoor air quality and hygiene and safety", and objective environmental measurements of sound levels, lighting, temperature, humidity, and reverberation time. The principal researcher went to the selected schools in order to collect the data. More details on the collection of individual data are presented in chapter 6. The environmental data was collected after collection of individual data. The principal researcher measured background noise levels, lighting, temperature, and humidity during working time inside classrooms and offices, and reverberation times were measured into empty workplaces during weekends or non-lectures times.

Instruments to collect individual data

The self-administered questionnaire consisted of seven sections with a total of 71 questions for teachers and 63 questions for non-teachers. The questionnaire was evidence-based on English sources. Since the official language in Colombia is Spanish – and we wanted to be sure that the interpretation of terms and phrases was conceptually equivalent – the questionnaire was translated English-Spanish-English. These instrument was designed in such a way that individual characteristics, voice functioning, lifestyle habits, work-related conditions, impact on quality of life due to voice disorders and economic consequences were included [10,22,25,27,40]. More details on

the questionnaire are presented in chapter 6.

The procedure for the voice recordings consisted of two parts. First, the participant filled out a short questionnaire, before recording the voice samples. The second part consisted of perceptual and objective (acoustic and aerodynamic) analyses of the voice samples by the researcher. More details on data collection and analysis of voice samples are presented in chapter 3.

The short questionnaire comprises 8 dichotomous questions about the current presence of health problems, including respiratory allergies, asthma, gastritis, gastro-esophageal reflux, and hearing impairment [26,27], and one multiple-selection question about current self-perceived severity of voice problem [41]. The voice recordings were analysed for perceptual and objective parameters. The voice perceptual analysis by means of the GRBAS scale, proposed by the Japanese Society of Logopedics and Phoniatrics. In the voice objective analysis, vowel samples were analysed for fundamental frequency in Hz (F0), pitch perturbation quotient in percentage (Jitter), amplitude perturbation quotient in percentage (Shimmer), and Maximum Phonation Time in seconds (MPT). All the acoustic analyses were carried out using the Praat Software developed by Paul Boersma and David Weenink, University of Amsterdam [42].

Instruments to collect environmental data

We used three instruments to collect the environmental data. The first instrument was the "Questionnaire on voice disorders" that the participants filled out. The second, a walk-through survey with the "Checklist for indoor air quality and hygiene and safety" that the principal researcher filled out. The third, objective environmental measurements of sound levels, lighting, temperature, humidity, and reverberation time (RT) were performed by the principal researcher during the visits to the workplaces (classrooms, offices, etc.).

The "Questionnaire on voice disorders" and the "Checklist for indoor air quality and hygiene and safety" were used to assess subjectively the working environment. The fourth part of the self-administrated questionnaire contained five questions on work-related factors, such as noise, acoustic conditions, temperature, humidity, and dust [25,27]. Through the walk-through survey, the indoor air quality, hygiene conditions and safety were evaluated by the researcher [43-48] consisted of four sections with 14 questions. The first section contained two questions about use of carpets and cleanness of the workplace. The second section comprises six questions about ventilation conditions such as type of ventilation, air movements, and odours at the workplace. In the third section, two questions addressed how comfortable the humidity at the workplace was. The fourth section comprises four questions about hygiene and safety conditions such as presence of waste materials, presence of conditions to prevent the entrance or harbourage of rodents, insects, and other vermin, dryness and cleanness of floors at the workplace.

Objective environmental measurements of background noise levels, lighting, temperature, and humidity were performed with the use of the 4 in 1 digital multi-function Environment-Meter (Wisemann Klein Mod WK040). This instrument has integrated the functions of sound level meter, light meter, humidity meter, and temperature meter [49]. The reverberation measurements were performed by the software RAMSES (Room Acoustic Measurement System). RAMSES is a patented measuring and analysing program for checking the acoustic conditions of a room [50].

Background noise levels (BNL), lighting, temperature and humidity were measured during actual teaching/working activities to obtain more representative and accurate indications of these factors for development of teaching-learning or working activities. BNL were measured inside the classrooms/workplace, and Sound Levels (SL) were measured outside the schools, using the frequency weighting (A) because this filter simulates the response of the human ear. The reverberation time measurements were performed into empty workplaces during weekends or non-lectures times.

Objective environmental measurements of BNL, lighting, temperature and humidity inside the workplaces were performed as follows: (1) there were taken in occupied classrooms or workplaces; and (2) at three different points within the classroom or workplace to cover the complete room. The measurement point "number one" was defined as the most common location of the teachers (or worker/non-teacher) inside the classroom (or the workplace). Objective environmental measurements of SL outside the schools were performed at the site of highest noise level. The Environment-Meter was positioned at a distance of 2 meters from walls; the duration of each measurement was 1 minute [51].

OUTLINE OF THIS THESIS

This thesis describes our work in eight chapters. Chapter 3, 4, 6 and 7 rely on data from the cross-sectional study, and chapter 5 on data from the follow-up study.

Chapter 2 presents a systematic review on occurrence and associated factors of voice disorders among teachers; this chapter addresses the first and third objectives of this thesis. **Chapter 3**, a cross-sectional study among 574 teachers, investigates how well objective measures of vocal performance correlate with vocal performance's subjective measures. This chapter addresses the second objective of this thesis. In **Chapter 4**, we present the extent to which occurrence and work-related factors of voice symptoms among 682 school workers. This chapter addresses the first and third objectives of this thesis. **Chapter 5** presents the longitudinal study with eleven-months-follow-up among 480 school workers and investigates the natural course of voice complaints among school workers and the risk factors associated with incidence and recurrence of voice complaints; this chapter addresses the first and third objectives of this thesis. In **Chapter 6**, we present the associated factors of voice related quality of life assessed by means of the Voice-Related Quality of Life (V-RQOL) and Voice Activity and Participation Profile (VAPP) instruments. This chapter addresses the fourth objective of this thesis. **Chapter 7** presents a cross-sectional study among 438 Colombian schoolteachers with voice complaints and investigates the medical costs and productivity costs of voice symptoms among teachers. This chapter addresses the fourth objective of this thesis. **Chapter 8** discusses the main research findings and methodological considerations and presents recommendations for future research and current practice.

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Chapter 2

Voice disorders in teachers and their associations with work-related factors: a systematic review

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ABSTRACT

To provide a quantitative assessment of the occurrence of voice disorders among teachers and to identify associated work-related and individual factors in the teaching profession. A systematic review was conducted using three computerized databases on the occurrence of voice disorders among teachers and their associations with work-related and individual factors. Some of the keywords used were: “teacher”, “voice disorder”, “voice problem”, “dysphonia”. Information regarding the occurrence of voice disorders and associations between work-related and individual factors and voice disorders were extracted from each paper. Occurrence and associations were expressed in prevalence and odds ratios, respectively. In total, 23 publications met the criteria for inclusion. All publications were cross-sectional studies. Prevalence estimates varied widely, reflecting disparity in definitions of “voice problem”. Teachers had a significantly increased occurrence of voice disorders compared to other occupations. Several work-related and individual factors were consistently associated with voice disorders, most notably high levels of noise in classrooms, being a physical education instructor, and habitual use of a loud speaking voice. This review shows that teachers report voice disorders more often than non-teachers do. Various work-related and individual factors are associated with reported voice disorders. Longitudinal studies are urgently required to get more insight into the development of voice disorders, their work-related determinants, and the consequences of these voice disorders for functioning and work performance among teachers.

Keywords:

voice disorder

occupational health

systematic review

teacher

INTRODUCTION

About one third of the labour force works in professions in which the voice is their primary tool [1]. Excessive use or abuse of the voice at work can lead to voice disorders [2]. ASHA defines voice disorders as the "abnormal production and/or absences of vocal quality, pitch, loudness, resonance, and/or duration, which is inappropriate for an individual's age and/or sex" [3].

Some studies suggest that workers, whose professions are vocally demanding, such as teachers, may be at greater risk for developing voice disorders [2,4,5]. Studies that have investigated voice disorders among teachers have reported a wide range of prevalence from 4.4% to 90%. Therefore, some authors have concluded that the prevalence of voice disorders in these workers is not well described [2,4].

Some studies have reported that voice disorders among teachers are associated with working conditions, such as background noise, extensive working hours without rest, and poor climatic conditions in classrooms [2,4,6-8]. Nevertheless, there is a clear lack of consensus about which working conditions are associated with the development of voice disorders in this occupation [4].

In order to establish the work-relatedness of voice disorders among teachers, studies are needed to characterize the relative importance of individual and work-related factors in the development of voice disorders among teachers [9]. Individual factors include voice use and teaching experience and work-related factors often referred to focus on the working environment and conditions of employment and payment [10,11].

To date, no systematic review of the literature concerning voice disorders among teachers and their work-related factors is available. Such a review may contribute to the second step in the process of evidence-based practice (i.e. finding the evidence) as advised by the American Speech-Language-Hearing Association [12].

Therefore, we conducted a systematic review of the available scientific literature with two aims: to provide a quantitative assessment of the occurrence of voice disorders among teachers and to identify work-related and individual factors of voice disorders among these teachers.

METHOD

Literature search

Comprehensive literature searches were conducted using three computerized databases: PubMed/MEDLINE (National Library of Medicine, Bethesda, Maryland) covering from 1966 to February 2011, Embase (Elsevier, Amsterdam, The Netherlands) covering from 1984 to February 2011, and The Cochrane (Central Register of Controlled Trials) covering from 1972 to February 2011. Originally, we aimed at inclusion of publications on all communication disorders, including voice disorders and hearing disorders, among teachers. However, due to the absence of studies on hearing disorders, the systematic review focused on voice disorders. The following search strings were used: (teacher OR teaching profession) AND (aphonia OR voice disease* OR voice disorder* OR dysphonia OR voice problem* OR speech disorder* OR vocal problem* OR vocal disease* OR voice handicap OR voice attrition OR hearing loss OR hearing impairment OR noise-induced hearing loss OR hypoacusis OR hearing illness OR vocal illness OR hearing disorder*) NOT (blindness OR sign language OR autistic disorder OR child*). The search was extended by screening the reference lists of all relevant publications identified.

Study Selection

Initially, titles and abstracts of all papers identified were screened. For final inclusion, publications had to fulfil all of the following criteria: 1) Report empirical data on the occurrence of voice disorders in teachers with or without a reference population; 2) Present a quantitative description of the association between work-related or individual factors with the occurrence of voice disorders among teachers with or without a reference population, and 3) Be published in peer-reviewed scientific journals written in English. The definition of a voice disorder was interpreted broadly and could include terms such as dysphonia, voice complaints, vocal symptoms, voice disorders, and vocal problems.

Figure 1 shows the process for identification of relevant publications. The literature search resulted in 214 potentially relevant publications (after exclusion of duplicates). A total of 23 publications on voice disorders met our inclusion criteria: Ahlander, Rydell, & Lofqvist, 2010; Angelillo, Di Maio, Costa, Angelillo, & Barillari, 2009; Chen, Chiang, Chung, Hsiao, & Hsiao, 2010; Chong & Chan, 2010; Da Costa, Prada, Roberts, & Cohen, 2010; De Jong, et al., 2006; De Medeiros, Barreto, & Assuncao, 2008; Jonsdottir, et al., 2002; Kooijman, et al., 2006; Miller & Verdolini, 1995; Pekkarinen, et al., 1992; Preciado-Lopez, Perez-Fernandez, Calzada-Uriondo, & Preciado-Ruiz, 2008; Roy, Merrill, Thibeault, Gray, & Smith, 2004; Roy, Merrill, Thibeault, Parsa, et al., 2004; Sala, Laine, Simberg, Pentti, & Suonpaa, 2001; Sliwinska-Kowalska, et al., 2006; Smith, Gray, Dove, Kirchner, & Heras, 1997; Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998; Smith, Lemke, Taylor, Kirchner, & Hoffman, 1998; Smolander & Huttunen, 2006; Thibeault, Merrill, Roy, Gray, & Smith, 2004; Thomas, Kooijman, Cremers, & De

Jong, 2006; Van Houtte, Claeys, Wuyts, & Van Lierde, 2010.

Publications were found from three research groups who wrote multiple articles that were based on the same study population, but that reported different work-related or individual factors in each article: Kooijman and De Jong et al [13,14], Roy et al [15-17] and Smith et al [18,19]. All of the publications met the inclusion criteria and were used for data extraction and methodological quality assessment.

Data extraction

The first author extracted relevant data from the publications on country and year of study, study population, sample size, voice disorders, and work-related and individual factors. An overview of the characteristics of the included publications appears in Appendix A.

The prevalence of voice disorders reported in 23 publications was classified in four categories: point (currently present), 12-month (present in the past year), lifetime (present any moment in the past) and unspecified period (no specific time period reported). These categories were then further grouped into a prevalence with a clearly defined recall time (point and 12-months period) and a prevalence without a clearly defined recall period (lifetime and unspecified recall period).

Factors associated with voice disorders were identified in the selected studies. Work-related factors were categorized into two groups: working environment related to acoustics and noise conditions, ventilation, lighting, temperature, and humidity and work organization and employment conditions including the topic and level of teaching, weekly work-load and gross annual income. Individual factors were related with voice use, psychosocial aspects, and years in teaching.

As measure of association between voice disorders and the teaching profession and between voice disorders and work-related and individual factors, the odds ratio (OR) with a corresponding 95% confidence interval (95% CI) was used. The OR is the ratio of the odds of the event of interest (i.e. voice disorders) occurring in one group to the odds of it occurring in another group [20]. ORs were directly extracted from 14 publications: Angelillo, Di Maio, Costa, Angelillo, & Barillari, 2009; Chen, Chiang, Chung, Hsiao, & Hsiao, 2010; De Jong, et al., 2006; De Medeiros, Barreto, & Assuncao, 2008; Kooijman, et al., 2006; Miller & Verdolini, 1995; Preciado-Lopez, Perez-Fernandez, Calzada-Uriondo, & Preciado-Ruiz, 2008; Roy, Merrill, Thibeault, Parsa, et al., 2004; Sliwinska-Kowalska, et al., 2006; Smith, Kirchner, et al., 1998; Smith, Lemke, et al., 1998; Smolander & Huttunen, 2006; Thibeault, et al., 2004; Van Houtte, Claeys, Wuyts, & Van Lierde, 2010. In 9 publications this information was not presented, and ORs were calculated based on the raw data provided: Ahlander, Rydell, & Lofqvist, 2010; Chong & Chan, 2010; Da Costa, Prada, Roberts, & Cohen, 2010; Jonsdottir, et al., 2002; Pekkarinen, et al., 1992; Roy, Merrill, Thibeault, Gray, & Smith, 2004; Sala, Laine, Simberg, Pentti, & Suonpaa, 2001; Smith, Gray, Dove, Kirchner, & Heras, 1997;

Thomas, Kooijman, Cremers, & De Jong, 2006.

Publication bias and assessment of methodological quality

Reported associations between related factors (work-related and individuals) and voice disorders did not depend on size of study population and study design. Hence, there were no indications for publication bias [21].

The 23 publications selected for this systematic review were assessed for methodological quality. The assessment was based on criteria from the Newcastle – Ottawa Quality Assessment Scale [22], distinguishing five topics: study population (definition and participation), assessment of exposure (definition, description, and blindness), assessment of outcome (definition, description, and blindness), study design and analysis (type of study and criteria), and data presentation (management and presentation of statistical information). Two authors read and assessed the publications independently, and all initial disagreement was resolved in a consensus meeting. A full description is presented in Appendices B and C. Linear regression analysis was conducted to evaluate whether the quality score was associated with reported prevalence and odds ratio in order to identify possible biased findings. This analysis was repeated with the quality score as dichotomous variable in order to evaluate whether studies of high quality reported similar findings as studies with low quality.

RESULTS

Occurrence of voice disorders

In total, 23 publications were included in this review, all reporting on cross-sectional studies. Table 1 summarizes the studies presenting a prevalence with a clearly defined recall period (point prevalence and 12-month prevalence). Most studies based their results on questionnaires. The point prevalence of voice disorders ranged from 9% [18] to 37% [23]. The 12-month prevalence ranged from 15% [24] to 80% [8]. Three publications presented a clinically verified prevalence of voice disorders, ranging from 17% [25] to 57% [26].

Table 2 presents the studies with a prevalence of voice disorders during lifetime or an unspecified recall period. In seven studies the life-time prevalence of voice disorders ranged from 51% [27] to 69% [28], whereas in 10 publications on prevalence without a defined period the proportion of teachers with voice problems ranged between 13% [7] and 94% [16].

Work-related factors and voice disorders

Table 3 shows the association between teaching profession and the occurrence of voice disorders. Sala et al (2001) provided information to calculate the odd ratios between three different voice disorder definitions (laryngitis, hoarseness and voice tired)

and teaching profession. Ten publications showed association with ORs ranging from 1.89 [16] to 4.61 [28].

Table 4 shows associations between specific work-related factors and the occurrence of voice disorders among teachers. Teachers who perceived high levels of noise in classrooms consistently reported more voice disorders than teachers who did not report such conditions with ORs varying between 1.51 [26] and 5.18 [24].

Associations between work organization and employment conditions with voice disorders were statistically significant in eight publications. Three publications showed statistically significant associations between teaching physical education and voice disorders [18,19,29].

Three publications found statistically significant associations between individual factors and voice disorders with the largest OR of 4.34 for using loud voice in teaching [30]. Teachers who reported high work pressure and use of loud voice during teaching reported more than three times the voice disorders of their teacher colleagues [23,30].

The associations presented above were most often based on univariate associations between work-related factors and voice disorders. In only six publications these associations were adjusted for the influence of other important factors for the occurrence of voice disorders, such as age and gender [15,17-19,30,31]. In two publications, it was possible to calculate crude ORs in order to compare adjusted and unadjusted ORs [15,30]. One study compared teachers and non-teachers and presented an adjusted OR of 2.04, whereas the crude OR was 1.85 (1.39-2.47) [15]. Another study investigwwated the use of loud voice among teachers and reported an adjusted OR of 4.34, whereas the crude OR was 3.19 [30].

Linear regression analyses showed that the quality score was not associated with reported prevalence of voice disorders and with associations between work-related factors and voice disorders. Studies of high quality did not present different findings than studies of low quality.

DISCUSSION

This review shows that voice disorders are an important health problem among teachers. Teachers had a significantly increased occurrence of voice disorders compared with other occupations. A large variation in reported prevalence of voice disorders was observed. For example, the prevalence of currently voice disorders ranged from 9% to 37% and 15% to 80% of all teachers reported to have experienced voice problems in the past 12 months.

This review identifies three important sources of variation. In general, publications with a high prevalence used the general terms “voice complaints” or “voice symptoms” in their questionnaire or asked for a wide range of specified symptoms [8,16,23]. In contrast, the publication with the lowest 12-month prevalence used a specific definition of a voice disorder - the presence of a tired voice or loss of voice quality [24]. Another reason for the observed variation in prevalence of voice disorders is the recall period, whereby a longer recall period will result in a higher prevalence than a short recall period.

We would like to highlight two elements for improved future analysis of voice disorders among teachers; short recall periods are suggested to avoid recall bias (answer about the voice disorder is affected by the respondent’s memory especially in the case of self-report). Second, future research on the correlation between objective measurements and self-reports of voice functioning and on their associations with working physical conditions are needed. It is advised to adopt a well-defined recall period that should not exceed 12 months in order to avoid recall bias [32].

Another important factor in the analysis of the large variation in the reported prevalence of voice disorders is the assessment method. Most studies (n=20) relied on self-reported symptoms with substantial differences in recall period. It is recommended to include objective assessment of voice functioning. Three papers reported the use of instrumental assessments of voice disorders by video laryngoscopy [26,28] or indirect laryngoscopy [25]. However, the prevalence even among these publications varied considerably. It is expected that studies that used videolaryngoscopy reported a higher prevalence than did studies with indirect laryngoscopy. Videolaryngoscopy offers more information about the presence or absence of motor/coordination abnormalities in the vocal folds, because a strobe makes the movement of the vocal cords visible, so that potential problems during phonation can be identified. Moreover, additional objective voice assessments, such as laryngoscopy and acoustic analysis, offer valuable information on vocal status and physiology and, thus, a much wanted addition to self-reports [9,33].

Several publications mentioned associations between different work-related factors and reported voice disorders. Several work-related factors were consistently associated with voice disorders, most notably high levels of noise in classrooms. Moreover, none of the studies used objective measurements of work-related factors and the self-reported factors may suffer from information and recall bias. Future research should complement the questionnaire information with objective measurement of exposure, such as reverberation time and intelligibility (understanding of spoken lan-

guage in a noisy environment) in order to describe comprehensively the working conditions. Self-reports of physical work-related factors offer information about level of satisfaction with aspects as noise or temperature [34]; but objective measurements of the physical conditions in the classroom, for example based on the international standard ISO 9921-2003, are required to determine the technical interventions needed to improve the physical environment [35-37]. All evidence was based on cross-sectional studies, which do not allow statements about causality.

We would like to draw particular attention to the opposite findings about class size and voice disorders. One publication showed that teachers with large class size had an approximately three times higher occurrence of voice disorders than teachers of smaller classes [13]. In contrast, another publication showed that teachers with larger class sizes were less likely to report voice disorders than teachers with smaller class size [38]. These contradictory findings are difficult to explain, but cross-sectional studies are very sensitive to reversed causality, whereby teachers with voice problems may be moved to smaller classes. It is recommended that future research with longitudinal studies address these selection effects. Longitudinal studies are urgently required to get more insight into the development of voice disorders, their work-related determinants, and the consequences of these voice disorders for functioning and work performance among teachers.

With respect to work organization and employment conditions, specifically topic of teaching, several publications consistently observed that physical education teachers reported voice disorders more often than teachers of other subjects did. A possible explanation may be the specific nature of physical education, which requires shouting in large spaces, often with bad acoustic conditions. These demands may be one of the causes of increased reporting of voice disorders among these teachers. A study on the level of teaching suggests that the younger the students the more often voice disorders will be prevalent among teachers [27]. It was suggested that the vocal load among primary and pre-school teachers is higher than the load for secondary teachers, because the former would have to compete against noise produced by the children during longer time periods without appropriate rest breaks (usually they teach all the topics by themselves) [25]. However, this association may be confounded by gender since there are more female teachers in the first years (pre-school and primary) of education, whereas male teachers are more common in secondary education [13,14,18]. The distribution of voice disorders by gender may differ; some authors suggest that women report voice disorders more often than men [18]. In addition, a considerable number of others associations were not adjusted for important characteristics. For example, the crude association between higher income and more voice disorders derived from Roy, Merrill, Thibeault, Parsa, et al (2004) became insignificant after adjustment for important confounders, such as age, gender, and seniority.

With respect to the individual factors, the association between years of teaching and voice disorders is not clear. Some authors have suggested that teachers with more years of experience report having voice disorders more often than teachers with fewer years in teaching [24,39], but other authors have reported an opposite relationship [40].

However, none of these publications found associations that were statistically significant. Once again, the cross-sectional nature of the studies prevents interpretation of these findings and the direction of the observed associations.

This systematic review has several limitations. A limitation is that only publications in the English language were included and, thus, relevant non-English publications might have been missed. A second limitation is that publication bias cannot be refuted, whereby publications with statistically significant findings are more easily published than other publications. A third limitation is that the quality of most of the included publications was scored as low. The five articles with lowest quality scores did not report information regarding the definition of voice disorders or did not have an appropriate comparison group [7,13,23,29,39]. Although the quality of the studies did not influence the reported findings, the overall low to modest quality illustrates that studies of better quality are highly needed, whether of cross-sectional or longitudinal design. Important improvements are the use of a short recall period for presence of symptoms, a well-defined description of symptoms, objective measurement of the working environment, and sufficient contrast in exposure to relevant determinants.

In conclusion, teachers have a high prevalence of voice problems. Teachers who work in noisy classrooms, teach physical education, or use a loud speaking voice are at greater risk of associated voice disorders. Longitudinal studies are urgently required to get more insight into the development of voice disorders, their work-related determinants, and the consequences of these voice disorders for functioning and work performance among teachers.

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Figure 1. Flow chart of the process for identification of included of publications

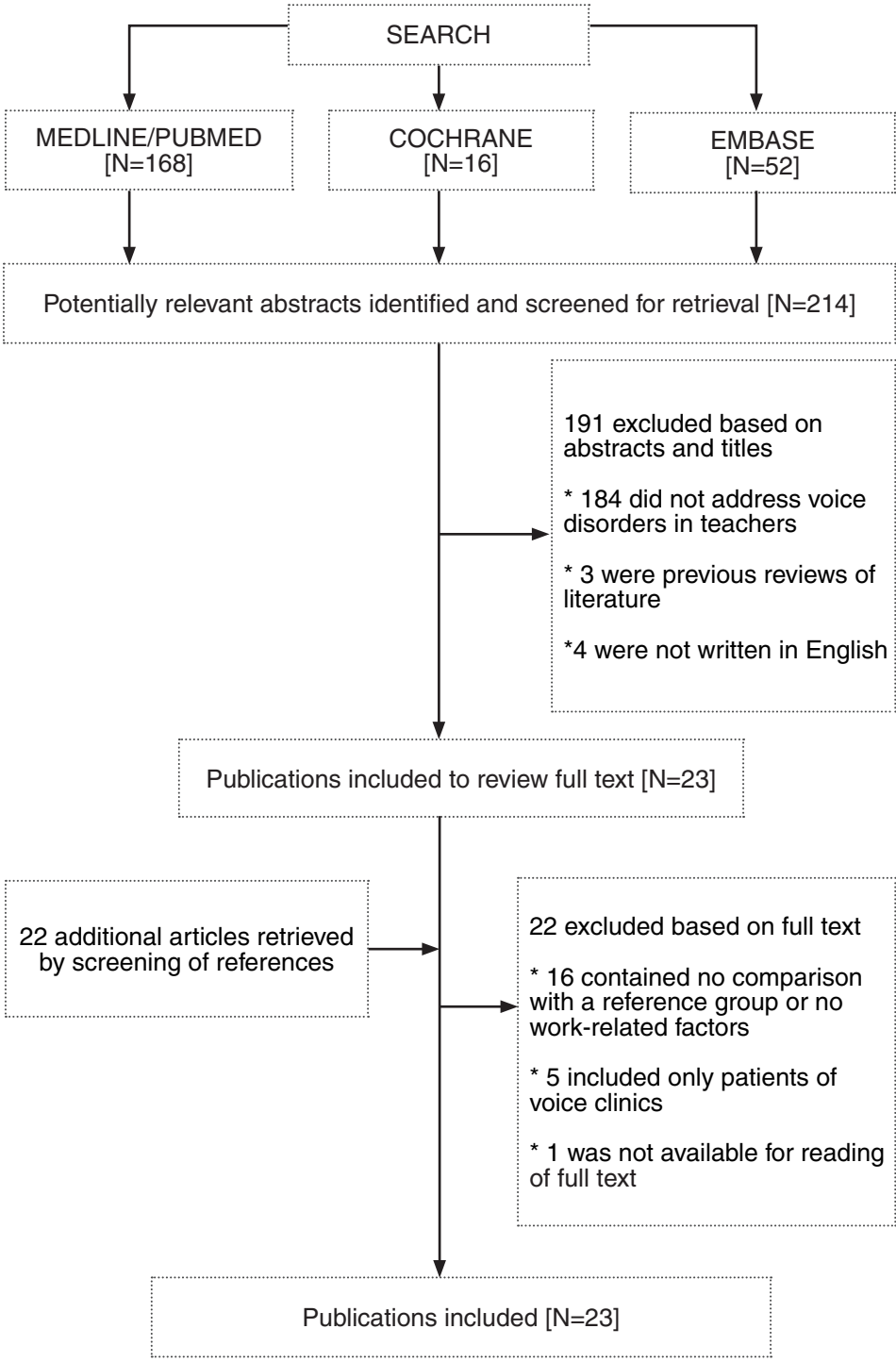

Table 1. Currently present voice disorders (point prevalence) and voice disorders in the past 12 months (12-month period prevalence) among teachers

Category of prevalence Study (first author /year/country)	Sample size	Voice Disorders	Prevalence % (95%CI)
Point prevalence			
Smith, Kirchner, 1998 (USA)	554 (274 M-280 F)	VS	9 (6-11)
Angelillo, 2009 (Italy)	504 (322 F-182 M)	VP	9 (6-11)
Roy, Merrill, Thibeault, Parsa, et al, 2004 (USA)	1243 (386 M-857 F)	VD	11 (9-13)
Smith, 1997 (USA)	242 (191 F-49 M)	VP	15 (10-19)
De Jong, 2006 (Netherlands)	1878 (892 M-987 F)	VC	18 (16-19)
Miller, 1995 (USA)	125 (64 F-56 M)	VP	21 (14-28)
Da Costa, 2010 (USA)	237 (182 F-55 M)	VP (HS)	22 (17-27)
Thomas, 2006 (Netherlands)	82 F	VC	37 (26-47)
12-month period prevalence			
De Medeiros, 2008 (Brazil)	2103 F	D	15 (14-17)
Sala, 2001 (Finland)	262 (257 F-5 M)	VD (VT)	31 (25-37)
De Jong, 2006 (Netherlands)	1878 (892 M-987 F)	VC	34 (32-37)
Thomas, 2006 (Netherlands)	82 F	VC	54 (43-65)
Pekkarinen, 1992 (Finland)	478 (315 F-163 M)	VS	80 (76-84)
Clinically verified point prevalence			
Sala, 2001 (Finland)	262 (257 F-5 M)	LAR	17 (12-22)
Sliwinska-Kowalska, 2006 (Poland)	425 F	AB	33 (28-37)
Preciado-Lopez, 2008 (Spain)	579 (380 F-199 M)	AB	57 (54-60)

M=Male; F=Female,

AB=Abnormalities of voice production process; LAR=Laryngitis; D=Dysphonia; HS=Hoarseness; VC=Voice Complaints; VD=Voice Disorder; VP=Voice Problems; VS=Voice Symptoms; VT=Voice Tired

Table 2. Voice disorders during lifetime (life-time prevalence) or in the past (prevalence with unspecified recall period) among teachers

Category of prevalence Study (first author /year/country)	Sample size	Voice Disorder[1]	Prevalence % (95%CI)
Life-time Prevalence			
Angelillo, 2009 (Italy)	504 (322 F-182 M)	VP	51 (47-56)
Van Houtte, 2010 (Belgium)	994 (670 F-324 M)	VD	51 (48-54)
De Jong, 2006 (Netherlands)	1878 (892 M-987 F)	VC	58 (56-60)
Roy, Merrill, Thibeault, Parsa, et al, 2004 (USA)	1243 (386 M-857 F)	VD	58 (55-60)
Thibeault, 2004 (USA)	1243 (385 M-858 F)	VD	58 (55-61)
Miller, 1995 (USA)	125 (64 F-56 M)	VP	64 (56-72)
Sliwinska-Kowalska, 2006 (Poland)	425 F	VS	69 (64-73)
Prevalence with unspecified recall period			
Jonsdottir, 2002 (Iceland)	85 (35 F-50 M)	D	13 (6-20)
Smith, Kirchner, 1998 (USA)	554 (274 M-280 F)	VS	32 (28-36)
Smith, Lemke, 1998 (USA)	554 (274 M-280 F))	VP	32 (28-36)
Ahlander, 2010 (Sweden)	467 (336 F-131 M)	VP	37 (32-41)
Preciado-Lopez, 2008 (Spain)	579 (380 F-199 M)	VD (FG)	45 (41-49)
Preciado-Lopez, 2008 (Spain)	579 (380 F-199 M)	D	48 (44-52)
Chen, 2010 (Taiwan)	117 (98 F-19 M)	VP	50 (41-59)
Preciado-Lopez, 2008 (Spain)	579 (380 F-199 M)	VD (VBR)	53 (49-57)
Kooijman, 2006 (Netherlands)	1878 (890 M-988 F)	VC	59 (56-61)
Smolander, 2006 (Finland)	181(138 F-43 M)	VP	65 (58-72)
Chong, 2010 (Hong Kong)	1710 (477 M-1233 F)	VD	74 (71-76)
Roy, Merrill, Thibeault, Gray, & Smith, 2004 (USA)	1243 (858 F-385 M)	VS	94 (92-95)

M=Male; F=Female

[1] D=Dysphonia; FG=Fatigue; HS=Hoarseness; VBR=Voice breaks; VC=Voice Complaints; VD=Voice Disorder; VL=Voice loss; VP=Voice Problems; VS=Voice Symptoms

Table 3. Association between teaching profession and prevalence of voice disorders

	Study Population				Voice Disorder[1]	OR (95% CI)
	Teachers		Non teachers (Reference)			
Study (first author /year/country)	**N**	**Prevalence (%)**	**N**	**Prevalence (%)**		
Point prevalence						
De Jong, 2006 (Netherlands)	1878	18	239	8	VC	2.49 (1.53-4.03)
Smith, 1997 (USA)	242	15	178	6	VP	2.88 (1.38-5.99)
Sala, 2001 (Finland)	262	17	107	6	LAR[2]	3.20 (1.35-7.58)
Sliwinska-Kowalska, 2006 (Poland)	425	33	83	10	VD[2]	4.61 (2.16 - 9.85)
12-month prevalence						
Pekkarinen, 1992 (Finland)	478	80	95	71	VS	1.63 (0.99-2.68)
Thomas, 2006 (Netherlands)	82	54	454	37	VC	1.99 (1.23-3.19)
Sala, 2001 (Finland)	260	26	108	10	VD(HS)	2.94 (1.47-5.89)
Sala, 2001 (Finland)	260	31	108	11	VD (VT)	3.62 (1.87-7.01)
Life-time prevalence						
Roy, Merrill, Thibeault, Parsa, et al., 2004 (USA)	1243	94	1158	89	VS	2.04 (1.55-2.68)[3]
Van Houtte, 2010 (Belgium)	994	51	290	28	VC (HS)	2.75 (2.06-3.66)
Miller, 1995 (USA)	125	64	49	33	VP	3.66 (1.82-7.38)
Angelillo, 2009 (Italy)	504	60	402	29	VP	3.72 (2.81-4.92)
Prevalence with unspecified recall period						
Smith, Lemke, 1998 (USA)	554	32	220	1	VP	1.20 (0.86-1.69)[4]
Roy, Merrill, Thibeault, Gray, & Smith, 2004 (USA)	1243	11	1288	6	VD	1.89 (1.41-2.53)

OR= odds ratio

[1] D=Dysphonia; HS=Hoarseness; LAR=Laryngitis; VC=Voice Complaints; VD=Voice Disorder; VP=Voice Problems; VS=Voice Symptoms; VT=Voice tired

[2] Clinical Examination

[3] Adjusted for age, gender, school grade and family history

[4] Adjusted for age, gender, years employed

Table 4. Associations (ORs and 95% CIs) between the occurrence of voice disorders among teachers and work-related and individual factors

Study (first author /year/country)	Voice Disorder[1]	N	Work-related and Individual Factors	OR (95% CI)
			Working environment	
			Acoustics and noise conditions	
Ahlander, 2010 (Sweden)	VP	467	7 to 15 vs. 1 to 6 students	0.27 (0.08-0.93)
			15 to 30 vs. 1 to 6 students	0.26 (0.12-0.54)
Kooijman, 2006 (Netherlands)	VC	1878	Large size of class vs. small size of class	3.24
Preciado-Lopez, 2008 (Spain)	VD	579	High vs. low noise level from classroom	1.51 (1.09-2.09)
			Echo in classroom vs. no echo in classroom	1.58 (1.09-2.29)
Kooijman, 2006 (Netherlands)	VC	1878	Acoustic and noise conditions (bad vs. good)	1.80
Ahlander, 2010 (Sweden)	VP	467	Bad acoustics vs. good acoustics	2.69 (1.39-5.23)
De Medeiros, 2008 (Brazil)	D	2103	High noise in classroom vs. negligible	5.18 (3.83-6.99)
			High noise within school vs. negligible	2.74 (2.08-3.61)
			High noise outside school vs. negligible	1.86 (1.32-2.61)
			Ventilation	
De Medeiros, 2008 (Brazil)	D	2103	Reasonable vs. satisfactory	1.76 (1.26-2.44)
			Poor vs. satisfactory	2.84 (2.00-4.04)
			Lighting	
De Medeiros, 2008 (Brazil)	D	2103	Reasonable vs. satisfactory	1.76 (1.30-2.37)
			Poor vs. satisfactory	3.28 (2.18-4.93)
			Temperature	
Kooijman, 2006 (Netherlands)	VC	1878	Temperature change in classroom vs. no change	1.48
			Humidity	
Kooijman, 2006 (Netherlands)	VC	1878	Humidity of classroom (yes vs. no)	1.84
Ahlander, 2010 (Sweden)	VP	467	Dryness vs. humidity in classroom	2.72 (0.97-7.58)
			Irritants	
Kooijman, 2006 (Netherlands)	VC	1878	Irritants in classroom (yes vs. no)	1.45
Sliwinska-Kowalska, 2006 (Poland)	IGC	425	Black-board chalk dust exposure (yes vs. no)	1.9 (1.0–3.4)
			Work organization and employment conditions	
			Topic of teaching	
Chong, 2010 (Hong Kong)	VD	1710	Physical education (yes vs. no)	1.46 (1.02-2.09)
Jonsdottir, 2002 (Iceland)	VS	85	Physical education vs. head teachers	2.97 (0.73-12.08)
Smith, Kirchner, 1998 (USA)	VS	554	Physical education (yes vs. no)	3.70 (1.4-9.5)[2]
			Biology/chemistry (yes vs. no)	2.10 (0.9-5.3)[2]
Smith, Lemke, 1998 (USA)	VP	554	Physical education (yes vs. no)	3.70 (1.45-9.47)[2]

Study (first author /year/country)	Voice Disorder[1]	N	Work-related and Individual Factors	OR (95% CI)
Thibeault, 2004 (USA)	VD	1243	Physical education (yes vs. no)	1.20 (0.8-1.8)[3]
			Chemical sciences (yes vs. no)	2.00 (1.1-3.4)[3]
			Drama (yes vs. no)	2.10 (0.9-4.8)[3]
			Vocal music (yes vs. no)	2.20 (1.2-4.0)[3]
			Level of teaching	
De Jong, 2006 (Netherlands)	VC	1878	Secondary education vs. primary education	1.20 (0.98-1.47)
Angelillo, 2009 (Italy)	VP	504	Primary education vs. secondary education	1.64 (1.05-2.57)
			Pre-school vs. secondary education	2.11 (1.32-3.36)
			Weekly workload (h/class)	
De Medeiros, 2008 (Brazil)	D	2103	22.50 h/class weekly vs. <22.50	1.07 (0.70-1.64)
			>22.50 h/class weekly vs. <22.50	1.74 (1.21-2.49)
Kooijman, 2006 (Netherlands)	VC	1878	High workload vs. lower workload	3.83 (3.11-4.71)
			Gross annual income	
Roy, Merrill, Thibeault, Parsa, et al, 2004 (USA)	D	1243	20.000 – 40.000 vs. <20.000 USD	1.67 (1.15-2.41)
			40.000 – 60.000 vs. <20.000 USD	2.16 (1.51-3.10)
			>60.000 vs. <20.000 USD	2.43 (1.70-3.48)
			Individual factors	
			Voice use	
Chen, 2010 (Taiwan)	VP	117	Using loud voice in teaching (yes vs. no)	4.34 (1.44-13.14)[5]
Smolander, 2006 (Finland)	VD	181	Voice use (shouting vs. not shouting)	2.8 (1.4–5.6)[4]
			Psychosocial aspects	
Thomas, 2006 (Netherlands)	VC	82	High work pressure (yes vs. no)	3.14 (1.88-5.27)
			Years in teaching	
Smith, 1997 (USA)	VS	242	1 - 10 years vs. more than 10 years	1.29 (0.74-2.23)
Da Costa, 2010 (USA)	D	237	More than 10 years vs. 1 - 10 years	1.40 (0.50-3.89)
De Medeiros, 2008 (Brazil)	D	2103	5-9 years vs. 0-4 years	1.04 (0.43-2.27)
			10-14 years vs. 0-4 years	1.43 (0.74-2.76)
			15-19 years vs. 0-4 years	1.66 (0.87-3.17)
			>20 years vs. 0-4 years	1.21 (0.65-2.25)

OR= odds ratio

[1] D=Dysphonia; IGC=Incomplete glottal closure; VC=Voice Complaints; VD=Voice Disorder; VP=Voice Problems; VS=Voice Symptoms; [2] Adjusted for age, gender and hours taught/day; [3] Adjusted for age, gender, and race/ethnicity

[4] Adjusted for town of residence, age, grade and subjects taught, working years, number of lessons taught per day, size of the school and class, diseases and asthma medication, and the amount of smoking and use of alcohol; [5] Adjusted for age, years in occupation, grade taught, using amplification, number of bad vocal habits, number of diseases, head and neck surgeries

Appendix A. Relevant data from the included publications

Study (first author /year/ country)	Study Population	Sample Size		Voice Disorders Definition[1]	Work-related Factors[2]
		Teachers	Non-Teachers		
Ahlander, 2010 (Sweden)	23 randomized schools were selected from a restricted geographical area	467 336 F 131 M	-	Voice problem (defined in terms of frequency of presentation (sometimes, often, or always vs. never or only occasionally))	Size of class, acoustic conditions, humidity
Angelillo, 2009 (Italy)	Teachers, randomly chosen in 28 schools of the district of Naples. Non-teachers were selected from people accompanying patients at the Department of Audiology and Phoniatric of the Second University of Naples.	504 322 F 182 M	402 244 F 158 M	Voice problem (presented voice troubles at the moment of the investigation or from the past: hoarseness, voice tired, difficulty projecting the voice, voice related discomfort, increased effort to talk, chronic throat dryness or soreness, trouble speaking or singing)	Teaching occupation, level of teaching
Chen, 2010 (Taiwan)	All teachers of 5 randomly selected elementary, middle, and high schools in Taipei City	117 98 F 19 M	-	Voice problem (often or always have suffered hoarseness, breathiness, tired voice, weak voice, strained voice, low note difficulty, high note difficulty, low speaking voice, high speaking voice or limited singing range)	Using loud voice
Chong, 2010 (Hong Kong)	Primary and secondary school teachers randomly selected from the Hong Kong Professional Teacher's Union database	1710 1233 F 477 M	-	Voice disorder (defined in terms of severity (none, little, some, severe))	Years in teaching, topic of teaching
Da Costa, 2010 (USA)	Kindergarten teachers in North Carolina	237 182 F 55 M	-	Voice problem or hoarseness (defined in terms of moment of occurrence (currently or past))	Years in teaching
De Jong, 2006 (Netherlands)	Teachers of primary and secondary education, and a control group of non-teachers with low and high vocal demands in their profession	1878 988 F 890 M	239 157 F 82 M	Voice complaints (defined in terms of the moment of occurrence (during the past year, at this moment, earlier during your teaching career))	Teaching occupation, level of teaching

Study (first author /year/ country)	Study Population	Sample Size Teachers		Voice Disorders Definition[1]	Work-related Factors[2]
De Medeiros, 2008 (Brazil)	Elementary education daytime teachers from 83 schools	2103 F	-	Dysphonia measured by asking “Have you felt too tired to speak during the past two weeks?” and “Have you perceived any loss of voice quality during the past two Weeks?”	Noise in classroom, noise within school, noise outside school, workload, ventilation, lighting, years in teaching
Jonsdottir, 2002 (Iceland)	Physical education teachers (who had nine or more teaching periods per week, each period being of 40 min) and head teachers of schools for pupils in the age of 6–15 years, both rural and urban	85 36 F 49 M	-	Voice symptoms: dry throat, lump in the throat, sore throat, tickly throat, hoarseness without a cold, stubborn cough, vocal tiredness when reading, vocal tiredness in singing, vocal tiredness in conversation, pitch breaks, voice fails to project in large rooms, aching shoulders, back ache, aching shoulder blades, muscular ache of the throat	Topic of teaching
Kooijman, 2006 (Netherlands)	Teachers of primary and secondary education	1878 988 F 890 M	-	Voice complaint assessed by asking “Have you experienced any voice complaints?”	Size of class, acoustic conditions, humidity, temperature, irritants, workload
Miller, 1995 (USA)	Teachers randomly selected from the National Association of Teachers of Singing (NATS). The control group consisted of friends and families of surveyed NATS members	125 64 F 56 M 5 NI*	49 25 F 24 M	Voice problem (including self-perceived abnormalities in voice output, in phonatory effort, or in any other voice-related function)	Teaching occupation
Pekkarinen, 1992 (Finland)	Teachers from 26 comprehensive, upper, business and vocational schools and a control group of nurses from two hospitals	478 315 F 163 M	95 93 F 2 M	Vocal symptoms (voice tires easily, hoarseness without a cold, pain around larynx, voice breaks, difficulty in being heard and aphonia without a cold); occurrence and frequency of occurrence during the last two years	Teaching occupation
Preciado-Lopez, 2008 (Spain)	Teachers from La Rioja; 492 randomly selected and 413 volunteered	905 589 F 316 M	-	Voice disorder measured by questionnaire: vocal overstrain symptoms (phonasthenia, odinophonia, itching and hoarseness, pharynx paraesthesia, change in voice quality, voice breaks) and clinical examination with videolaryngoscopy: abnormal stroboscopic findings	Noise in classroom, echo in the classroom

Study (first author /year/ country)	Study Population	Sample Size		Voice Disorders Definition[1]	Work-related Factors[2]
		Teachers	Non-Teachers		
Roy, Merrill, Thibeault, Parsa, et al, 2004 (USA)	Teachers aged 20-66 years old from Utah and Iowa, full-time elementary and secondary school and a control group of working and nonworking subjects in each state of the same age category	1243 857 F 386 M	1288 775 F 513 M	Voice disorder (any time the voice does not work, perform, or sound as it normally should, so that it interferes with communication)	Teaching occupation, gross annual income
Roy, Merrill, Thibeault, Gray, & Smith, 2004 (USA)	Teachers aged 20-66 years old from Utah and Iowa, full-time elementary and secondary school and a control group of working and nonworking subjects in each state of the same age category	1243 857 F 386 M	1158 676 F 482 M	Voice disorder (any time the voice does not work, perform, or sound as it normally should, so that it interferes with communication). Voice symptoms (hoarseness, voice tires, trouble speaking or singing softly, difficulty projecting voice, loss of singing range, discomfort while using voice, effort to talk, monotone voice, chronic throat dryness, chronic throat soreness)	Teaching occupation
Sala, 2001 (Finland)	People from 27 day care centres who work with children. Randomly selected nurses working at the Turku University Central Hospital served as the control group	262 256 F 6 M	108 105 F 3 M	Voice disorder measured by questionnaire: having vocal symptoms (throat clearing, voice tires easily, hoarseness, sore throat or globus, voice breaks, difficulty in being heard, aphonia) weekly or more often, and/or an abnormal voice quality; and by clinical examination with indirect laryngoscopy: signs of erythema and edema both in the vocal cords and the hypopharynx	Teaching occupation
Sliwinska-Kowalska, 2006 (Poland)	Professionally active teachers (working for more than 1 year) of different schools and universities and a control group of female office workers with no vocal loading (either work-related or connected with leisure-time activities)	425 F	83 F	Voice symptoms measured by questionnaire: hoarseness, vocal tiredness, getting voiceless, aphonia, chronic dryness in the throat, sensation of "lump" in the throat and persistent dry cough; and abnormalities in the voice production process by clinical examination with videostrobocopic examination: assessment of voice quality, type of phonation, voice instability, breathing technique, correctness of articulation, activation of supraglottic resonators, presence of nasalization and neck muscle tension during voicing, and determination of maximum phonation time	Teaching occupation, topic of teaching, black board chalk dust
Smith, Lemke, 1998 (USA)	Public and private school teachers randomly selected from the Iowa Board of Education tape and a control group of employed non-teachers	554 280 F 274 M	220 144 F 76 M	Voice problem measured by asking "Have you ever had a voice problem?"	Teaching occupation, topic of teaching

Study (first author /year/ country)	Study Population	Sample Size		Voice Disorders Definition[1]	Work-related Factors[2]
		Teachers	Non-Teachers		
Smith, 1997 (USA)	Primary and secondary teachers selected from a north-eastern Nevada and a northern Utah school and a control group of employed adults solicited from 1993 to 1995 with non-voice related conditions	242 193 F 49 M	178 127 F 51 M	Voice problem measured by asking "Do you currently have a voice problem?"	Teaching occupation, years in teaching
Smith, Kirchner, 1998 (USA)	Public and private school teachers randomly selected from the Iowa Board of Education	554 280 F 274 M	-	Voice symptoms (hoarseness, tired voice, lower than normal speaking voice, weak voice, effortful, higher than normal speaking voice, voice spasms, breathy)	Topic of teaching
Smolander, 2006 (Finland)	Comprehensive schoolteachers in Oulu and Helsinki of several suburban and urban districts of both towns.	181 138 F 43 M	-	Voice problem (presence of voice symptoms (vocal fatigue, sense of a lump in the throat, a need for clearing and hoarseness that worsened during the day))	Voice use (shouting)
Thibeault, 2004 (USA)	Teachers aged 20-66 years old from Utah and Iowa, full-time elementary and secondary school.	1243 857 F 386 M	-	Voice disorder (any time the voice did not work, perform, or sound as it usually does for that person such that it interfered with communication)	Topic of teaching
Thomas, 2006 (Netherlands)	Female teachers for primary education early in their professional teaching and a control group of female student teachers for primary education	82 F	454 F	Voice complaints measured by asking "Have you ever experienced voice complaints?" "Do you experience voice complaints at this moment?" and "Did you experience voice complaints during the past year?"	Teaching occupation, work pressure
Van Houtte, 2010 (Belgium)	Teachers of kindergarten, elementary and high school and a control group of non-teachers with jobs without vocal effort	994 670 F 324 M	290 206 F 84 M	Voice disorder (any time the voice did not work, perform, or sound as it usually does and interfered with communication)	Teaching occupation

*NI=Not Informed

[1] All the studies measured prevalence of voice disorders with a questionnaire. When clinical examination was also used, this was specified

[2] All the studies measured work-related and individual factors with a questionnaire

Appendix B. Assessment of methodological quality

A quality assessment list was constructed using criteria from the Newcastle – Ottawa Quality Assessment Scale [22]. The list has 19 items organized in five topics: *study population* (definition and participation), *assessment of exposure* (definition, description, and blinded procedure), *assessment of outcome* (definition, description, and blinded procedure), *study design and analysis* (type of study and criteria), and *data presentation* (management and presentation of statistical information). Each item could be scored 0 or 1, depending on the presence (positive score) or absence (negative score) of the criterion (1= presence of the criterion; 0= absence of the criterion or a lack of clarity as to the presence of the criterion). The maximum score was 19. Articles in this review were categorized as high methodological quality (>=13), or low methodological quality (<13) according to their methodological quality scores (MQS).

Methodological quality assessment list. Based on New Castle-Ottawa Quality Assessment Scale.

	Item	Scoring options
	Study population	
1	Study groups (teachers and non-teachers) are clearly defined	Positive=At least 2 of 3: age, gender (number, percentage), working time exposure
2	Participation >=70%	Positive=Participation was >70%
3	Number of cases >=50	Positive=Total number of cases >50
4	Case definition	Positive=Definition adequate, with independent validation, not self-report
5	Representativeness of the cases	Positive=No potential for selection bias
6	Selection of comparison group	Positive=Drawn from the same community
7	Definition of the comparison group	Positive=No history of voice disorders or No history of presence of the work-related or individual factors
	Assessment of work-related and or individual	**Factors**
8	Factor definition	Positive=Factor clearly defined
9	Assessment of factor status	Positive=Assessment of factors was described
10	Blind for factor status	Positive=Factors were assessed by an independent person and not based on self-report
	Assessment of voice disorder	
11	Voice disorder definition	Positive=Voice disorder clearly defined
12	Assessment of voice disorder status	Positive=Assessment of voice disorder was described
13	Blind to voice disorder status	Positive=Voice disorder measured without knowledge of work-related or individual factor by an independent person, not self-report
	Study design and analysis	
14	Type of study	Positive=Case control study
15	Inclusion and exclusion criteria	Positive=Criteria described
	Data presentation	
16	Presentation of frequencies of the voice disorders and/or factors	Positive=The frequencies are presented
17	Presentation of risk estimates measurements	Positive=The authors show OR in the paper
18	Adjusted for at least age and gender	Positive=The OR's are adjusted for age and gender
19	Consideration of confounders	Positive=Confounders that were considered were described

Appendix C. Methodological quality scores of the selected articles

Study (first author /year/country)	Voice Disorder[1]	Item numbers[2]																			Summary Score[3]
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Roy, Merrill, T hibeault, Parsa, et al, 2004 (USA)	VD	+	+	+	-	+	+	+	+	+	-	+	+	-	-	+	+	+	+	+	15
Roy, Merrill, Thibeault, Gray, & Smith, 2004 (USA)	VD	+	+	+	-	+	+	+	+	-	-	+	+	-	-	+	+	+	+	+	14
Miller,1995 (USA)	VP	+	-	+	-	-	+	+	+	+	-	+	+	-	-	+	+	+	+	+	13
De Medeiros, 2008 (Brazil)	D	+	+	+	-	+	-	-	+	-	-	+	+	-	-	+	+	+	+	+	12
Sliwinska-Kowalska, 2006 (Poland)	VD	+	-	+	-	-	+	+	+	+	-	+	+	-	-	+	+	+	-	+	12
Smith, Lemke, 1998 (USA)	VP	+	-	+	-	-	+	+	+	+	-	-	+	-	-	+	+	+	+	+	12
Thibeault, 2004 (USA)	VD	+	+	+	-	+	-	-	+	+	-	+	+	-	-	-	+	+	+	+	12
De Jong, 2006 (Netherlands)	VC	+	-	+	-	-	+	-	+	+	-	+	+	-	-	+	+	+	+	-	11
Sala, 2001 (Finland)	VD	+	-	+	+	-	+	+	+	+	-	+	+	-	-	+	+	-	-	-	11
Pekkarinen, 1992 (Finland)	VS	+	+	+	-	+	-	+	+	+	-	+	+	-	-	-	+	-	-	-	10
Smith, 1997 (USA)	VP	+	-	+	-	-	+	+	+	+	-	-	+	-	-	+	+	+	-	-	10
Ahlander, 2010 (Sweden)	VP	+	+	+	-	+	-	-	+	+	-	-	+	-	-	+	+	-	-	-	9
Angelillo, 2009 (Italy)	VP	+	-	+	-	-	+	+	+	-	-	-	+	-	-	+	+	+	-	-	9
Preciado-Lopez, 2008 (Spain)	VD	-	-	+	+	-	-	-	+	+	-	+	+	-	-	+	+	+	-	-	9
Van Houtte, 2010 (Belgium)	VS	-	-	+	-	-	-	+	+	+	-	+	+	-	-	+	+	+	-	-	9
Chen, 2010 (Taiwan)	VP	+	-	+	-	-	-	-	-	+	-	+	+	-	-	-	+	+	-	+	8
Kooijman, 2006 (Netherlands)	VC	+	-	+	-	-	-	-	+	+	-	+	+	-	-	-	+	+	-	-	8
Smolander, 2006 (Finland)	VC	-	-	+	-	-	-	-	-	+	-	+	+	-	-	+	+	+	-	+	8
Chong, 2010 (Hong Kong)	VD	+	-	+	-	-	-	-	+	+	-	-	+	-	-	+	+	-	-	-	7
Da Costa, 2010 (USA)	VP	+	-	+	-	-	-	-	-	+	-	+	+	-	-	+	+	-	-	-	7
Smith, Kirchner, 1998 (USA)	VS	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-	+	+	+	+	7
Thomas, 2006 (Netherlands)	VC	-	-	+	-	-	-	-	+	+	-	+	+	-	-	-	+	+	-	-	7
Jonsdottir, 2002 (Iceland)	D	+	+	-	-	+	-	-	+	-	-	-	+	-	-	-	+	-	-	-	6
Item score positive		19	7	22	2	7	9	10	20	18	0	16	22	0	0	16	23	17	8	10	

[1] D=Dysphonia; VC=Voice Complaints; VD=Voice Disorders; VP=Voice Problems; VS=Voice Symptoms

[2] See Appendix B for item criteria

[3] Score ≥13= high quality

Chapter 3

Are there any associations between self-perceived voice complaints in teachers, perceptual voice assessment by a speech therapist, and objective voice analysis?

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Submitted

ABSTRACT

To assess agreement between self-perceived voice complaints, perceptual assessment, and objective voice analysis; to determine factors associated with the perceptual assessment of voice disorders; and to determine the added value of objective voice analysis in the clinical diagnosis of voice disorders among teachers. We conducted a community-based cross-sectional study. The participants were 574 teachers in 12 public schools in Bogota. After signing the informed consent form, participants filled out a questionnaire on voice complaints. Then, a voice sample was recorded and evaluated perceptually by a speech therapist based on the GRBAS scale and by objective voice analysis with PRAAT software. Agreements between GRBAS scale, self-reported voice complaints, and objective voice analysis were determined by the Kappa coefficient and receiver operating characteristic curves. Multivariate logistic regression analysis was used to identify variables associated with the therapist-based perceptual assessment. Diagnostic performance of these variables in combination with self-reported voice complaints and objective voice analysis for therapist-based perceptual assessment was assessed by the area under the curve (AUC). No agreement between self-reported voice complaints and GRBAS assessments was found. Maximum phonation time showed a slight discrimination between those with voice problems and those without voice problems, as determined by GRBAS scale and by self-reports. The best diagnostic model with individual characteristics, self-reported voice complaints, and objective parameters resulted in a poor AUC of 0.67. Self-reported voice complaints, perceptual assessment by a speech therapist and objective voice analysis showed large differences and may offer different information about voice quality and functioning.

Keywords:

voice complaints, perceptual voice assessment, acoustic voice analysis, teacher

INTRODUCTION

Voice disorders are a multi-factorial and a multi-dimensional phenomenon [1], commonly reported among teachers [2]. Previous research has shown that estimates of voice disorder prevalence in teachers vary considerably, which can partly be explained by the use of different assessment methods of voice disorders [3]. In studies with self-reported voice symptoms in the last 12-months the prevalence ranged from 15% [4] to 80% [5], whereas in studies that used instrumental assessment of voice disorders (i.e. video or indirect laryngoscopy) the prevalence ranged from 17% [6] to 57% [7].

Most studies on voice disorders among teachers have used questionnaires [3], since it is a cheap and easy method to assess voice problems, and voice users could be considered good experts on their own voices [8]. Some studies have relied on perceptual voice assessment by a speech therapist [6,9,10]. Such assessment is considered cheaper, quicker, and more comfortable than acoustic or clinical assessments [11]. Only few studies on voice disorders have included acoustic voice analysis including aspects such as sound pressure levels, fundamental frequency (F0), jitter, shimmer and alpha ratio [12,13]. Although these three assessment methods evaluate different aspects of voice problems, it would be expected to find some association among them. However, there is considerable ambiguity about the relationships between these assessment methods [14,15]. Some studies did show relationships between self-reported voice complaints, perceptual assessment by speech therapist and clinical or acoustic measurements [16-19], but other studies have failed to corroborate these findings [8,12,20]. A recent study on perceptual assessment using the well-known GRBAS scale and acoustic analysis of the voice reported a correlation coefficient of 0.22 between the overall quality of the perceptual assessment (G score) and fundamental frequency, and of 0.53 between the G score and maximum phonation time [19]. One study reported a strong relationship between self-reported voice complaints and fundamental frequency with a correlation coefficient of 0.74 [18]. On the other hand, another study showed a complete lack of agreement between perceptual evaluation of voice by the GRBAS scale and self-reported voice complaints with a kappa coefficient of 0.03 [9].

Various studies have reported associations between individual factors, such as using loud voice in teaching and years in teaching with self-reported voice complaints among teachers [4,7,21,22]. However, to our knowledge no study has consistently evaluated whether these individual factors are also associated with the perceptual assessment of voice disorders and, thus, could contribute to diagnostic procedures. A similar question may be raised for the added value of objective voice analysis in the diagnosis of voice disorders among teachers.

To address these issues, we conducted a community-based cross-sectional study among 574 Colombian teachers with three aims: 1) to assess agreement between self-perceived voice complaints, perceptual assessment by speech therapist, and objective voice analysis; 2) to determine factors associated with clinician-based perceptual assessment of voice disorders; and 3) to determine the added value of objective voice analysis in the diagnosis of voice disorders among teachers.

METHODS

Design and Participants

This study is part of a larger research on voice disorders among teachers [23-25]. At the start of the school year (February and March 2012), a convenience sample of 12 primary and secondary schools in Bogota D.C. were selected to participate in this study. After approval of the Department of Education of Bogota and the head teachers of these public schools, all teachers (n=1446) were invited to participate in this cross-sectional study, thereby creating a study population large enough to meet the required sample size of 440 teachers with sufficient discriminatory power. Teachers who wanted to take part of this study filled out a questionnaire and recorded a voice sample. At some schools (n=6) the questionnaire was filled out on the same day that the voice sample was recorded. At the other schools (n=6), there was a gap of several days between filling out the questionnaire and recording the voice samples. All teachers gave written informed consent to participate in this study, which had the approval of the Medical Ethics Committee of the Universidad del Rosario in Colombia.

Data collection procedures

Questionnaire

We designed a questionnaire based on existing English-language questionnaires described in the literature [21,22,26]. The questionnaire was designed in a way to allow us collecting data on socio-demographic information, presence and characteristics of voice symptoms in the past month, lifestyle habits known to be associated with voice disorders, work-related conditions, voice-related quality of life and economic consequences. In addition, a short survey was included to collect information on health conditions that have been associated with the occurrence of voice disorders [22,27,28], such as respiratory diseases, gastritis and gastroesophageal reflux, and hearing impairment. The questionnaire has been described in more detail in previous publications [23,24].

Self-perceived voice complaints

The presence or absence of voice complaints was determined by a single question (included in the short survey) on severity of self-perceived voice problems: Do you experience voice problems now? Participants were asked to indicate whether they considered their voices as normal, almost normal, incipient problem, moderate problem or severe problem. Since the frequency of answers for some categories was low, in further analysis the presence of voice complaints was considered a dichotomous variable with subjects who answered incipient problem to severe problem categorized as having voice complaints.

Voice samples

To avoid background noise as much as possible, voice samples were recorded in a quiet, empty classroom or in the teachers' lounge. We collected two voice samples: One reading sample and one vowel production sample. First, participants were instructed to read a fragment of the text 'El Caballero de la Armadura Oxidada' (The Knight in Rusty Armor, a standardized text in Spanish with 223 words [29]), at a comfortable and conversational pitch, with loudness as naturally as possible, and not in a singing voice. The duration of the reading was about 90 seconds. Next, participants were requested to produce a sustained vowel /i/ as long as possible, at a comfortable pitch and loudness and not in a singing voice. The samples were recorded using portable digital recorders (Sony™, Olympus™ and RCA™). The digital recorder was placed at a short distance of 5-6 cm from the mouth in order to minimize possible effects of room acoustics [13]. The reading was used for a perceptual assessment by a speech therapist and the vowel sample was used for objective voice analysis.

Perceptual assessment by speech therapist

The GRBAS scale, proposed by the Japanese Society of Logopedics and Phoniatrics, was chosen for perceptual assessment of the voice, because it has been demonstrated to be efficient in several studies [17,30]. This scale includes an overall quality (G), based on roughness (R), breathiness (B), asthenia (A), and stress (S). As in previous research, a G score was used as a measure of the overall quality based mainly on the other four components [31]: the R score which reflects the perturbation of pitch, amplitude and noise in the low-frequency region; the B score which reflects noise below the mid-frequencies and high-expiratory airflow; the A score which reflects irregularity of pitch and amplitude, as well as vocal hypo-function; and the S score which reflects a higher pitch, noise in the higher frequencies, increased amplitude of the higher harmonics, and increased pitch and amplitude perturbation [32]. Each component is evaluated on a 4-point rating scale (0 for normal, 1 for slight dysphonia, 2 for moderate dysphonia, and 3 for severe dysphonia) [33]. The overall quality (G score) was expressed based mainly on the highest score on any of the four specific components.

The principal researcher, a speech therapist with ample experience in perceptual voice assessment, listened to the reading samples blinded for the information from the questionnaire regarding self-reported voice complaints. Because some components rarely received scores above zero, a dichotomous variable was used in the statistical analysis with subjects having a G score of one or above considered to be affected individuals.

Objective voice analysis

Vowel samples were analysed for three acoustic parameters: fundamental frequency in Hertz (F0), pitch perturbation in Percentage (Jitter), amplitude perturbation in dB

(Shimmer), and one aerodynamic parameter: maximum phonation time in seconds (MPT). A segment from the midpoint of the vowel produced by each participant was subjected to objective analysis with the PRAAT Software [34]. For further analysis, we calculated means and standard deviations (SD).

Our MPT protocol was based in previous studies [35,36]. Teachers were requested to sit upright and to produce a sustained vowel /i/ at a comfortable pitch and loudness. They were instructed to take a maximal inhalation and holding the vowel /i/ as long as possible. The examiner illustrated to teachers how to perform the sustained vowel /i/ production by holding /i/ for a couple of seconds with her own voice. Then, the examiner showed how long teachers should hold the vowel /i/ by imitating the end of the sustained production. Since the presence of fatigue effects after several MPT trials have been reported [37] and the high reliability using a single trial of MPT (reliability coefficient=0.94) [38], teachers were request an MPT of /i/ once. However, when teachers did not perform the task as instructed the first time, they were request to repeat the sustained vowel production three times with a 30-seconds rest period between each trial.

Statistical Analysis

Epi-info 3.5.3 software [39] was used for data entry, and SPSS 20 software for statistical analysis. Differences in socio-demographic aspects, work-related factors, health conditions, self-reported voice problems, and objective voice parameters between teachers with voice disorders, as diagnosed by perceptual assessment, and those without voice disorders were compared by Chi-square test and the t-test. Firstly, we calculated the Kappa coefficient to assess the agreement between the perceptual assessment by the speech therapist (G score) and self-reported voice complaints. The agreement between objective voice parameters with perceptual assessment and self-reported complaints was assessed by Receiver Operating Characteristic (ROC) curves, whereby the area under the curve (AUC) reflects the level of accuracy by which an objective parameter can predict the presence of voice disorders diagnosed by the speech therapist or the presence of self-reported voice complaints. An AUC of 0.5 reflects a complete absence of any agreement, an AUC of one presents a perfect agreement, and an AUC of 0.70-0.80 is considered a fair accuracy. In addition, sensitivity (proportion of teachers with voice disorders who were correctly classified) and specificity (proportion of healthy teachers who were correctly classified) were calculated. Secondly, we used logistic regression analysis to determine which factors were associated with perceptually determined voice disorders. For the independent variables, those with a p-value of maximal 0.20 in the univariate analyses were included in the multivariate analysis in order to avoid residual confounding [40], and were only retained when the p-value reached the conventional level of significance of 0.05. The magnitude of the association was expressed as the odds ratio (OR), and its 95% confidence interval (95% CI). Thirdly, we tested whether the added value of objective voice analysis and individual characteristics would improve the diagnosis of voice disorders. Again, the AUC was

used as measure of accuracy of these models. Cut-off values for objective parameters were determined for the optimal sensitivity and specificity.

For the perceptual assessment by speech therapist, intra- and inter-listener agreement were assessed by means of Kappa coefficient. We selected randomly a sample of voice recordings (n=30), which were listened to and rated by two speech therapists with experience in assessment of work-related voice disorders. One of these was the principal researcher and the other one was the second author. The intra-listener agreement of the principal researcher was evaluated by assessing the sample of voice recordings in two different randomized orders on each of two separated days by 5 weeks.

RESULTS

Participant characteristics

Table 1 describes the participants' characteristics. In total, 574 out of 621 teachers recorded voice samples and therefore made up the study population. Most teachers were female (n=407). The mean age of the study population was 45 years, ranging from 23 to 65 years. Teachers with a diagnosed voice disorder by perceptual assessment (G score of 1 or above) were older compared with teachers without a voice disorder.

Self-reported voice complaints, perceptual assessment, and objective voice analysis

As shown in Table 1, the prevalence of self-reported voice complaints was higher than the prevalence of voice disorders identified by perceptual assessment (63% vs. 45%). This difference was statistically significant. Teacher with a voice disorder had higher jitter and shorter maximum phonation times compared with participants without voice disorders. However, these differences were substantially less than meaningful clinical differences.

Agreement between self-reports of voice complaints, perceptual assessment, and objective speech analysis

A poor agreement between self-reported voice complaints and perceptual assessment by the speech therapist was found (kappa coefficient =0.12). Self-reported voice complaints had little discriminatory value for perceptually diagnosed voice disorders (AUC=0.56; SE=0.02). As shown in Table 2, the objective parameters had little discriminatory value for perceptually diagnosed voice disorders (AUC between 0.50 and 0.59) and for self-reported voice complaints (AUC ranged from 0.50 to 0.57). The specificity was low with values ranging from 0.26 - 0.31, whereas sensitivity was sub-

stantially higher with values between 0.69 and 0.82.

Associations with perceptual assessment

Table 3 shows those factors that were associated with a perceptually diagnosed voice disorder. Teachers with self-reported current voice complaints had a higher likelihood (OR=1.70) of being perceptually diagnosed with a voice disorder than those without self-reported voice complaints. Teachers with longer maximum phonation time (OR=0.95) had less often a perceptually diagnosed voice disorder. Female gender (OR=1.77), older age (OR=1.05) and self-reported gastrointestinal diseases (OR=1.49) were also associated with voice disorders diagnosed by a speech therapist. The multivariate analysis showed that after mutual adjustment for relevant factors in univariate analyses, age and maximum phonation time remained associated with perceptually diagnosed voice disorders.

Diagnostic models for voice disorders by perceptual assessment

Table 4 shows the diagnostic models for voice disorders. The most restrictive model including only those variables were statistically significantly associated with voice disorders (i.e. age and maximum phonation time) had the lowest AUC of 0.64. The subsequent addition of self-reported voice complaints, other objective parameters and individual factors increased the AUC to a maximum value of 0.67, which reflects a poor accuracy.

Reliability

Our results indicated a good intra-listener agreement of the principal researcher (kappa coefficient=0.71). On the contrary, a fair inter-listener agreement between the two speech therapists was found (kappa coefficient=0.33).

DISCUSSION

In this study, we assessed agreement between self-reported voice complaints, perceptual assessment by a speech therapist, and objective voice analysis among teachers with a high prevalence of voice problems. In addition, we investigated the associated factors and predictive factors for diagnosed voice disorders by a perceptual assessment. Our findings indicate that perceptual assessment by a speech therapist had no to little agreement with self-reported voice complaints and objective voice analysis. The agreement between self-reported voice complaints and objective parameters with voice disorders determined by perceptual assessment was poor with an area under the curve of 0.67.

The prevalence of diagnosed voice problems of 42% in our study population of teachers is in line with the results of Lima-Silva et al (2012), who found among teachers a prevalence of 43% for voice disorders identified using auditory-perceptive assessment. Our results indicated no agreement between perceptual assessment by speech therapist, self-reported voice complaints and objective parameters, such as jitter and shimmer. This finding is in line with the results of Lima-Silva et al (2012) who reported a complete lack of agreement (kappa coefficient of 0.03) between voice disorders identified by perceptual assessment (assessed on the GRBAS scale) and self-reported voice complaints. This lack of agreement may have several reasons. A first explanation is that both assessment by the speech therapist and self-perceived complaints are subjective and, hence, will suffer from systematic and random measurement error. Both types of error will attenuate any association between both measures of voice quality. In this regard, previous publications have mentioned the influence of internal standards on assessment of voice in both self-perceived complaints and perceptual assessment [11,41]. A second explanation is that the perceptual assessment addresses different aspects of voice problems than self-reported complaints. The latter was a generic measure of any problems perceived, while the overall GRBAS assessment targeted mainly 4 components of voice quality which do not necessarily encompass all voice problems perceived by teachers [42]. A third explanation is that the perceptual assessment was performed by listening to teachers' voices on a recording, whereas teachers assessed their voices with their perception but not listening to their own voices on a recording. Then, both professional and self-reported assessments would represent different aspects of voice production. This lack of agreement is troublesome, since the voice problems of teachers who seek medical advice may not be confirmed by perceptual assessment of speech therapists or clinicians. Moreover, teachers may look for health professional advice due to slight changes in their voice quality, but health professionals (ENT, speech therapist) who are used to deal with more severe problems may rate their voices as normal [8].

Our finding that self-reported voice complaints were not associated with a reduced fundamental frequency is in agreement with previous studies that reported no correlation between voice symptoms and fundamental frequency [12,43]. Nevertheless, our results contrast with Rantala et al (1999) who reported a strong correlation between fundamental frequency and self-reported voice complaints (r=0.74). We suggest several

reasons for these contradictory results. First, studies that did not report correlations used specific definitions of voice complaints, such as vocal fatigue or certain number of symptoms, whereas Rantala and colleagues used a broad definition of voice complaints including sick leave due to voice disorders. Second, studies that reported no correlation included in their population subjects with and without voice complaints, whereas Rantala et al (1999) included teachers with few complaints or many complaints. Finally, although Rantala and colleagues reported moderate correlations, they found no significant differences in mean values of F0, which is in concordance with our results. For clinical practice, it seems likely that teachers are able to identify small changes in their voice production or in their voice quality even before any changes can be detected by objective assessment techniques [8].

We would like to highlight the relationship between perceptually diagnosed voice disorders by the speech therapist and maximum phonation time (MPT). MPT was the only parameter associated with both the G score (AUC=0.59) and presence of self-reported voice complaints (AUC=0.56). In agreement with our results, a previous study showed a moderate correlation between perceptual assessment and MPT (r=0.53) [19]. It seems that the length of time that a person can sustain a vowel sound with relatively comfortable pitch and loudness was the only objective parameter that was consistently related, albeit with low to modest correlations, to overall voice quality by GRBAS assessment and self-reported voice complaints. From the clinical point of view, we may suggest that the association between perceptually identified voice disorders and MPT is due to the latter is a factor related to the balance of airflow during phonation. Since breathing is an important factor during voice production, and unbalanced airflow may cause changes on the quality of voice, it seems likely that MPT is a good indicator of the voice quality determined by perceptual assessment.

Moreover, when we studied which factors were associated with perceptually determined voice disorders, MPT along with age remained associated with perceptually detected voice disorders. These results suggest that older teachers with shorter phonation times are more likely to be identified with voice disorders compared with younger teachers with longer phonation times.

The diagnostic performance of individual characteristics, work-related factors, self-reported voice complaints and objective parameters for the therapist-based diagnosis was poor. All models showed similar sensitivity and specificity and differences between AUCs were small. The best model with seven parameters had a sensitivity of 0.83 and a specificity of 0.33. The high sensitivity implies that most teachers with a voice disorders were correctly classified. Hence, the use of this model could be considered as a first step in an initial screening tool for ascertainment of the absence of voice disorders, but additional evaluation tests and a more formal development of a decision model would be required to target those workers with voice disorders. On the other hand, because of the low specificity, this model cannot identify well those teachers without a reduced voice quality and, hence, will misclassify a substantial proportion of these teachers into the category of teachers with voice problems who may need medical guidance. In short, since most workers will be misclassified in the

current model, its use in practice is not advocated.

This study has several limitations. The first limitation relates to missing data since around 9% of participants did not record a voice sample. However, some authors suggest that statistical analysis with less than 10% of missing data is not likely to be biased [44]. A second limitation was the cross-sectional nature of this study, which does not allow to study the relationship over time between self-reported voice complaints, objective voice analysis, and diagnosis by perceptual assessment. Hence, it is not known whether these complaints or objective parameters are early signs of a reduced voice quality or whether reduced voice quality precedes the occurrence of voice complaints. Third, the perceptual assessment was performed by a single listener, which may have reduced the reliability of ratings. Our results on the intra- and inter-reliability suggested good intra-listener agreement, which is in concordance with previous research that reported a kappa coefficient of 0.70 [45,46]. Nevertheless, we found fair agreement between listeners, whereas some studies have shown a moderate to high inter-listener agreement of the GRBAS score ranging from 0.4 [45] to 0.7 [30]. Previous research have reported different sources of low inter-listener agreement in perceptual assessment [11,47,48]. In the current study, the perceptual assessments by both listeners were performed in different places under different conditions, and without external comparison stimuli as a reference material before judgments were made. Other internal factors, such as listener fatigue or perceptual sensitivity of the listener have been reported. However, we do not have enough information to speculate on the influences of these internal factors in the perceptual assessments performed by both listeners. Fourth, the MPT estimation was based on only one sustained vowel production. This could attenuate the associations of MPT with self-reported voice problems and perceptual assessment when MPT has a high variability within subjects. However, we decided to rely on only one vowel production since a previous study has shown a high reliability of 0.94, which clearly suggest a low variability within subjects.

In conclusion, there was no agreement between self-reported voice complaints, perceptual assessment by a speech therapist, and objective voice analysis. These different methods of assessment may offer complementary information about voice disorders. Hence, it is not advisable to rely on a single method to ascertain the presence of voice problems. The predictive power of self-reported voice complaints and objective parameters to identify perceptually diagnosed voice disorders was poor. Future research is needed to develop better diagnostic models for voice perceptual assessment.

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Table 1. Socio-demographic characteristics, self-reported health conditions, self-reported work-related factors, self-reported voice complaints and objective voice parameters of 574 teachers in 12 public schools in Bogotá D.C., Colombia

	Voice disorders perceptually diagnosed	
	NO	**YES**
Variable	**(n=315)**	**(n=259)**
Socio-demographics		
Age, years [mean (SD)]*	43.96 (9.42)	47.88 (9.25)
Female [n (%)]*	207 (66)	200 (77)
Graduate education level [n (%)]	81 (26)	71 (27)
Self-reported health factors		
Respiratory diseases [n (%)]	116 (37)	95 (37)
Gastrointestinal diseases [n (%)]*	140 (44)	141 (54)
Hearing Impairment [n (%)]	95 (30)	75 (29)
Self-reported work-related factors		
High noise at workplace [n (%)]	211 (67)	173 (67)
Poor acoustics at workplace [n (%)]	113 (36)	98 (38)
Dry air at workplace [n (%)]	143 (45)	122 (47)
Changes of temperature at workplace [n (%)]	164 (52)	144 (56)
Dust at workplace [n (%)]	173 (55)	146 (56)
Self-reported voice problems		
Current voice problems [n (%)]*	177 (56)	178 (69)
Objective analysis of voice		
Fundamental frequency, Hz [mean (SD)]	175.02 (58.21)	171.81 (51.25)
Jitter, % [mean (SD)]	0.61 (1.09)	0.70 (1.09)
Shimmer, dB [mean (SD)]	0.62 (0.41)	0.68 (0.48)
Maximum phonation time, seconds [mean (SD)]*	14.11 (5.54)	12.45 (5.57)

* Difference between groups significant ($p < 0.05$)

Table 2. Correlations between objective voice parameters and perceptual assessment by speech therapist and self-reported voice complaints among 574 teachers in 12 public schools in Bogotá D.C., Colombia

			Perceptual assessment by speech therapist			Self-report of voice complaints		
Factor	**Mean (SD)**	**Cut-off**	**AUC (SE)**	**Sensitivity**	**Specificity**	**AUC (SE)**	**Sensitivity**	**Specificity**
Objective Parameters								
Maximum phonation time (seconds)	13.36 (5.61)	19.97	0.59 (0.02)	0.81	0.31	0.56 (0.03)	0.77	0.29
Jitter (%)	0.65 (1.09)	0.23	0.57 (0.02)	0.82	0.26	0.57 (0.03)	0.80	0.26
Shimmer (dB)	0.65 (0.45)	0.37	0.53 (0.02)	0.72	0.32	0.50 (0.03)	0.69	0.28
Fundamental Frequency (Hz)	173.55 (55.13)	123.85	0.50 (0.02)	0.76	0.29	0.52 (0.03)	0.75	0.28

AUC: Area under the curve; SE: Standard Error

Table 3. Associations of self-reported voice complaints, objective voice parameters, socio-demographic characteristics and health-related conditions with presence of perceptual voice assessment by speech therapist in 12 public schools in Bogotá, Colombia

	Univariate analysis		Multivariate analysis	
Factor	**OR**	**95% CI**	**OR**	**95% CI**
Self-reports				
Self-reported voice complaints	1.70*	(1.21 - 2.40)	1.47	(0.99 - 2.18)
Objective voice parameters				
Fundamental Frequency (Hz)	1.00	(0.99 - 1.00)		
Jitter (%)	1.08	(0.92 - 1.26)		
Shimmer (dB)	1.36+	(0.93 - 1.98)	1.25	(0.82 – 1.91)
Maximum phonation time (seconds)	0.95*	(0.92 - 0.98)	0.96*	(0.93 - 0.99)
Socio-demographics				
Female gender	1.77*	(1.22 - 2.57)	1.52	(0.98 - 2.36)
Age (years)	1.05*	(1.03 - 1.07)	1.05*	(1.02 - 1.07)
Undergraduate education level	0.68+	(0.44 – 1.03)	0.91	(0.56 - 1.47)
Self-reported health conditions				
Respiratory diseases	0.99	(0.70 - 1.39)		
Gastrointestinal diseases	1.49*	(1.07 - 2.07)	1.22	(0.83 - 1.79)
Hearing Impairment	0.94	(0.66 - 1.35)		

OR: Odds Ratio; CI: Confidence Interval

* $P < 0.05$; + $p < 0.20$

Table 4. Performance of diagnostic models for voice disorders by perceptual assessment

Model	AUC (SE)	95% CI	Cut-off of score	Sensitivity	Specifity
Model 1	0.67 (0.03)	(0.62 - 0.72)	0.34	0.83	0.33
Model 2	0.67 (0.03)	(0.62 - 0.72)	0.34	0.81	0.35
Model 3	0.65 (0.03)	(0.60 - 0.70)	0.34	0.82	0.31
Model 4	0.64 (0.03)	(0.59 - 0.69)	0.34	0.84	0.29

AUC: Area under the curve; SE: Standard Error; CI: Confidence Interval

Model 1: Maximum phonation time + Shimmer + self-reports of voice complaints + Gastrointestinal diseases + Age + Sex + Education

Model 2: Maximum phonation time + Shimmer + self-reports of voice complaints + Age + Sex + Education

Model 3: Maximum phonation time + Shimmer + self-reports of voice complaints + Age

Model 4: Maximum phonation time + Age

Chapter 4

Effects of noise and acoustics in schools on vocal health in teachers

Cantor Cutiva, Lady Catherine; Burdorf, Alex

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ABSTRACT

Previous studies on the influence of noise and acoustics in the classroom on voice symptoms among teachers have exclusively relied on self-reports. Since self-reported physical conditions may be biased, it is important to determine the role of objective measurements of noise and acoustics in the presence of voice symptoms. To assess the association between objectively measured and self-reported physical conditions at school with the presence of voice symptoms among teachers. In 12 public schools in Bogotá, we conducted a cross-sectional study among 682 Colombian school workers at 377 workplaces. After signed the informed consent, participants filled out a questionnaire on individual and work-related conditions and the nature and severity of voice symptoms in the past month. Short-term environmental measurements of sound levels, temperature, humidity, and reverberation time were conducted during visits at the workplaces, such as classrooms and offices. Logistic regression analysis was used to determine associations between work-related factors and voice symptoms. High noise levels outside schools (Odds ratio [OR] 1.83; 95% confidence interval [CI] 1.12-2.99) and self-reported poor acoustics at the workplace (OR = 2.44; 95% CI 1.88-3.53) were associated with voice symptoms. We found poor agreement between the objective measurements and self-reports of physical conditions at the workplace. This study indicates that noise and acoustics may play a role in the occurrence of voice symptoms among teachers. The poor agreement between objective measurements and self-reports of physical conditions indicate that these are different entities, which argue for inclusion of physical measurements of the working environment in studies on the influence of noise and acoustics on vocal health.

Keywords:

Acoustics, noise, teacher, voice symptoms, work-related factors

INTRODUCTION

The places where we live and work can present hazards to our health and wellbeing [1]. Several studies in school environments have investigated the effects of environmental factors, such as noise levels, acoustic conditions, and indoor air quality, on children's health and performance [2-10]. However, these environmental factors may also influence the health and wellbeing of teachers [11,12]. Teachers have been recognized as one of the largest groups of professional voice users [13,14]. In general, voice disorders are more prevalent among teachers than in other occupational groups, but the reported prevalences range from 9% [13] to 94% [15], strongly depending on definition of severity and duration of symptoms. This wide range hampers a clear evaluation of the contribution of work-related factors to the occurrence of voice disorders among teachers.

Previous studies on work-related factors of voice disorders among teachers have relied on self-reported physical conditions, such as high background noise and poor acoustics in the classrooms [16]. De Medeiros *et al*. (2008) found that teachers who reported high background noise levels in the classroom or outside school had twice as often voice symptoms than teachers who did not report these conditions. Other studies have shown that poor acoustics in the classrooms was associated with voice symptoms among teachers with odds ratios (OR) ranging from 1.80 [17] to 2.69 [18]. Poor ventilation (OR = 2.84) [19] and large changes in temperature (OR = 1.48) [17] were also associated with voice disorders among teachers. Other studies have focused on objective measurements of physical conditions (noise, reverberation time [RT], temperature) in the classrooms. These studies have concluded that noise and acoustic conditions are the primary uncomfortable factors in teachers´ workplaces with background noise levels up to 87 dB [20-22] and RTs higher than 0.50 s [22-24]. To the best of our knowledge, only one study has indicated that voice disorders were more prevalent among teachers who worked in schools with higher noise levels [25]. Hence, there is a lack of studies using objective measurements of work-related factors (such as background noise levels, RT, humidity, temperature), and the presented associations may suffer from information and recall bias.

Although objective measurements of physical conditions at the workplace are more expensive with high technical and personnel requirements compared with self-reports, it is recommended to complement self-reports with such measurements in order to describe comprehensively the working conditions. Self-reports are influenced by the level of satisfaction with physical conditions of the workplaces [22], , whereas objective measurements provide exposure levels as well as guidance to determine the technical requirements of the physical environment [23,24,26]. Thus, there is a need for observational studies that investigate associations of objective measurements of physical conditions in the classroom with the presence of voice symptoms among teachers.

Therefore, we conducted a cross-sectional study within **682** Colombian school workers (621 teachers and 61 non-teachers) at **377** workplaces in **12** schools. The aims of the study were to assess the agreement between objective measurements and self-reports of physical conditions at the workplace and to evaluate their associations

with the presence of voice symptoms among teachers.

METHODS

Design and participants

This cross-sectional study was carried out in 12 public schools in Bogotá, Colombia (1,449 teachers, and 143 non-teachers). The Department of Education of Bogota selected by convenience sampling the primary and secondary schools to participate in this study. The principal researcher had group and individual meetings with the head teachers of those schools in order to describe the purpose and requirements of the study and to invite them to participate. After, the principal researcher had group meetings with school workers to inform about the aims of the study and the voluntary and confidential nature of participation. Other characteristics of the sampling procedure have been described previously [27]. The study protocol was agreed by the Department of Education of Bogotá, the Universidad del Rosario in Bogota, and Erasmus University Medical Center in Rotterdam. The study was approved by the Medical Ethics Committee of the Universidad del Rosario in Colombia, and complied with the ethical principles embodied in the Declaration of Helsinki.

Data collection procedures

Data collection took place in February and March of 2012 (at the start of the school year). The questionnaire was designed to collected information on individual characteristics, voice functioning, lifestyle habits, work-related conditions, and health conditions possibly related to voice disorders. In addition, short-term objective measurements of physical conditions at the workplace were conducted.

Questionnaire

For this study we developed a questionnaire that was based on existing English-language questionnaires described in the literature [13,17,28] and consisted of 71 questions for teachers and 63 questions for non-teachers. Other characteristics of the design and characteristics of the questionnaire have been described previously [27].

The first part of the questionnaire contained questions about sex, age, and education. The second part of the questionnaire contained questions about the presence of voice symptoms in the past month (tired voice, vocal fatigue, dry throat, itchy sensation and pain in throat, hoarseness, weak voice, voice spasms, voice loss, strained voice, breathiness); frequency (once, once every couple of weeks, weekly, daily), severity (mild, moderate, severe) and duration (open question) of these symptoms; whether the voice was affected while singing or speaking; aggravation of voice symptoms at work over time; and improvements during non-work periods in weekends and holi-

days. The presence or absence of voice symptoms was determined using the dichotomous question "Have you had voice symptoms in the past month?" [13,28].

The next part of the questionnaire contained questions about working conditions [29], including five questions about work-related factors, such as noise, acoustic conditions, temperature, humidity, and dust. For these physical factors, participants were asked to indicate whether they considered them uncomfortable: Always, often, sometimes or never. Since the frequency of answers for some categories was low, in further analyses physical factors were used as dichotomous variables, with subjects who answered "always" or "often" considered as being exposed. We also included questions about the presence of health conditions known to be associated with voice symptoms, such as respiratory diseases, gastrointestinal diseases; and hearing impairments [17,30,31].

Objective environmental measurements

We conducted objective measurements of sound levels (SLs) using the frequency weighting (A), temperature, humidity, and RT at the workplaces and SL outside schools. In the workplaces, SL, temperature and humidity were measured during actual teaching or working activities at three different locations to cover the complete workplace. The first position was defined as the most common location where the teacher (or worker) was located most of the time during the lecture (work time). The second position was close to the door and the third position was close to the windows. The duration of each measurement was 1 min each [32]. The RT measurements were performed in non-occupied workplaces during weekends or non-lectures times. The measurements outside the schools were aimed at identifying the highest noise level at a distance of 2 meters from walls [23]. SLs (dB), temperature (°C) and humidity (% RH) were measured with the 4 in 1 digital multi-function Environment-Meter Mod WK040, which integrates the functions of SL meter, light meter, humidity meter, and temperature meter. Measurements of RT (RT_{60}) were performed at 40 Hz, 50 Hz, 63 Hz, 80 Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz, 800 Hz, 1000 Hz, 1250 Hz, 1600 Hz, 2000 Hz, 2500 Hz, 3150 Hz, 4000 Hz, 5000 Hz, 6300 Hz and 8000 Hz by the Room Acoustic Measurement System. In all statistical analyses, we used the average of the three measurements performed at the workplaces. In addition, for further analysis, we calculated the average value of RT of all 24 frequencies ranging from 40 Hz to 8000 Hz. All the objective measures of environmental factors were dichotomized, whereby subjects under the 75th quartile were used as a reference group.

Statistical analysis

Epi-info 3.5.3. (CDC/2011) software developed by Center for Disease Control and Prevention (CDC) in Atlanta (USA) [33] was used for data entry, and SPSS 20 software, one of the brands under IBM software Group´s Business Analytics Portfolio, in New York (USA) [34] was used for statistical analysis. The statistical analysis was conducted on the study population with complete information on all variables. Since for some independent variables a few missing values occurred, multiple imputation was performed. Descriptive statistics was used for characteristics of the study population. The Shapiro-Wilk test was used to evaluate whether variables were normally distributed. Since menopause-related hormonal changes that may affect the voice of both men and women start around the age of 50 years [35], we dichotomized the variable age using a cut-off value of 50 years of age. Because teachers could work in more than one classroom within a school, we calculated the average value of all environmental measures across all classrooms as the exposure measure per teacher. Since physical characteristics of workplaces may vary within and between schools, an analysis of variance was used to estimate the proportion of variance due to schools and workplaces within the schools. To assess the association between the objectively measured and self-reported work-related factors, we calculated the mean difference in objective measures between subjects with self-reported exposure to these factors and those subjects without. We used multiple logistic regression analysis to investigate associations between objectively measured and self-reported work-related factors with voice symptoms. Variables with a *P* value below 0.20 in the univariate analyses were included in the multivariate analysis in order to avoid residual confounding [36], and were only retained when the *P* value reached the conventional level of significance of 0.05. In the final multivariate analysis, associations were adjusted for socio-demographic characteristics and health conditions. The magnitude of the association was expressed by the OR, and the statistical significance as the 95% confidence interval (95% CI).

RESULTS

Participant characteristics

In total, 682 participants were enrolled in this study with the same response among teachers and non-teachers (43%). A non-response analysis showed no association between the proportion of participants and prevalence of voice symptoms among the participating schools. Compared with non-teachers, teachers were younger and more often women. No differences were observed in self-reported occurrence of health conditions or work-related factors between teachers and non-teachers. As shown in Table 1, teachers (71%) were more likely than non-teachers (54%) to report voice symptoms in the past month (OR = 2.03, 95% CI: 1.19-3.46). The four self-reported physical conditions were weakly correlated (Spearman's rho correlation coefficients between 0.17 and 0.20).

The study population worked at 377 workplaces (345 classrooms, 12 playgrounds, 19 offices, and 1 library) of which 338 workplaces (90%) could be visited for objective measurements. Since RT measurements were performed in non-occupied workplaces and availability was not always guaranteed, this factor was measured in 248 workplaces. On average, 31 workplaces were measured per school with little variation in a number of workplaces measured per school. Table 2 shows noise levels, relative humidity, temperature, and RT in workplaces and noise levels outside schools. Differences in physical conditions were much larger between workplaces within schools than between schools. As shown in Table 3, for subjects who reported the presence of uncomfortable physical conditions the objective measurements at their workplaces showed similar mean values than for the workplaces of subjects without reporting exposure to these physical conditions.

Work-related factors of voice symptoms

Table 4 describes that high noise outside the school (OR = 1.90) and poor acoustics in the workplace (OR = 2.44) were associated with the occurrence of voice symptoms, whereas no statistically significant associations were observed for other physical conditions. Participants who worked in schools with high noise levels in the surroundings reported voice symptoms more often than participants who worked in schools with noise levels below 80 dB(A) (OR = 1.88). The results of the multivariate analysis showed that the associations between high noise levels in the surroundings and self-reported poor acoustics in the classrooms remained statistically significant and changed little after adjustments for socio-demographic factors and health conditions.

DISCUSSION

In this study, we investigated the association between objectively measured and self-reported physical conditions at school with the presence of voice symptoms among teachers. Our findings showed that the noise in the surroundings of schools and self-reported poor acoustic conditions were important work-related factors of voice symptoms. We found poor agreement between objective measurements and self-reports on noise and acoustics. In conclusion, this study suggests that acoustics and noise may be important elements to take into account in the design of schools in order to reduce voice disorders among teachers.

The univariate analyses of potential risk factors for voice symptoms showed that objectively measured noise outside the school, and self-reported high noise levels and poor acoustics in the workplaces were strongly associated with the presence of voice symptoms. The multivariate analysis showed that only objectively measured high noise levels in the surroundings of school and self-reported poor acoustics remained associated with voice symptoms. In the current study it was not possible to disentangle completely the relative importance of acoustics and noise in schools, since both

factors were interrelated. However, the multivariate analysis suggests that voice symptoms were stronger associated with poor acoustics than with noise.

We suggest three reasons to explain the lack of association between objectively measured environmental aspects (noise, RT, temperature and humidity) with voice symptoms. First, the physical conditions were short-term measurements on a single day. The results may not necessarily reflect well the average conditions encountered by teachers during their school year. Second, average noise and RTs were high, which may indicate a lack of discriminatory power to compare teachers in good physical working conditions with those with high exposure. Third, individual sensitivity may vary whereby some teachers will experience already voice symptoms at much lower levels of exposure to environmental risk factors than others.

Although classroom acoustics guidelines have not been fully developed in most countries, national and international recommendations on acceptable exposure levels at the workplace have recommended that the noise level should not exceed 50 dB(A) and that the RT should be below 0.6 s for optimal student learning [37,38]. In Colombia, the Department of Environment, Housing and Land Development recommends a Maximum L_{Aeq} in school zones during daytime of 65 dB(A) [39], and a Maximum L_{Aeq} of 55 dB(A) inside classrooms [40]. In this study we found, on average, background SLs around 72 dB(A), and 1.78 s of RT. The interquartile range of the distribution across workplaces shows that there were few workplaces with good acoustics, which may have limited our ability to demonstrate associations between these physical conditions and the presence of voice symptoms. The average values far exceed national and international recommendations, which will have important implications for the vocal health of teachers. Voice use in noisy or acoustically poor environments require repetition and loud voice use without distinction of occupation. However, it seems likely that teachers may require loud voice use and repetition more often than non-teachers in order to maintain the attention of the students and to overcome poor acoustics and noise in classrooms. Permanent loud voice use under these conditions seems to contribute to increased loading of vocal organs and thereby, contributing to the higher proportion of voice symptoms among teachers [18,19,29,41]. Activity noises were measured during actual teaching or working activities at three different positions for 1 min each. However, these moments were scheduled by the head-teachers of each school. Each head-teacher informed us the day and hour that were available to perform the environmental measurements in each school. No specific conditions were determined to choose the measurement moments, except that the day of measurements (noise, temperature and humidity) was a regular day of academic activities.

In order to propose appropriate noise reduction and acoustic solutions strategies inside classrooms, it is important to identify the effect of particular noise sources on specific performance variables. We found that high noise levels in the surroundings of the school building were strongly associated with voice symptoms. Schools with higher outside noise levels were those located near to main streets, commercial areas, or to the airport. This finding is in concordance with previous studies that have shown that road traffic and aircraft noise interferes with speech and teaching inside classrooms,

since external high noise levels may influence internal noise levels [11,42]. Therefore, lower RTs and lower noise levels are important elements to consider in the design of schools in order to reduce voice disorders among teachers. It is recommend to take into account the location of school buildings and sound insulation of the building when planning their construction, since it seems that external high noise levels have important effect on internal noise levels and thus on vocal health in teachers.

A major limitation of this study was the cross-sectional study design, which does not allow insight into the causality of the reported associations: We have no information on the relationship over time between the potential risk factors identified and the onset and perseverance of voice symptoms. Another limitation is the low response of the participants. However, the non-response has most likely not biased the prevalence of the voice symptoms because there was no association between high response and prevalence of voice symptoms among the participating schools. A third limitation was that random sampling of schools and teachers within schools was not feasible. Since selection of school and participants was not based on prior knowledge on the occurrence of voice symptoms or noise levels in the classroom, a systematic bias due to convenience sampling seems unlikely.

In conclusion, this study presented some indications that poor acoustics and high noise levels at the workplace may contribute to the occurrence of voice symptoms among teachers. However, these associations were based primarily on self-reports and could not be corroborated by objective measurements of physical conditions at the workplace.

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Table 1 Socio-demographic characteristics, voice symptoms, health conditions and work related factors of teachers and non-teachers in 12 public schools in Bogotá D.C., Colombia

	Teachers (n=621)		Non-Teacher (n=61)	
Variable	**N**	**%**	**N**	**%**
Prevalence of voice symptoms in past month	438	71	33	54
Socio-demographics				
Female gender*	444	71	34	56
Age (years)*				
< 50	402	65	26	43
50 +	219	35	35	57
Postgraduate studies	175	28	23	38
High school and Bachelor	225	36	12	20
Other levels of education	221	36	26	43
Self-reported health conditions				
Respiratory diseases	228	37	27	44
Gastrointestinal diseases	305	49	28	46
Hearing impairment	186	30	14	23
Self-reported work-related factors				
High noise in workplace	413	67	34	56
Poor acoustics in workplace	385	62	32	52
Dry air in workplace	300	48	33	54
Large changes in temperature in workplace	345	56	29	48

* Chi-square test, $P<0.05$

Table 2 Physical characteristics of 338 workplaces in 12 public schools in Bogotá D.C., Colombia

					Sources of Variance	
Measure	**Workplaces**	**Mean**	**SD**	**Interquartile Range**	**Between schools**	**Between workplaces within schools**
				(25% - 75%)	**%**	**%**
Background noise levels in workplace (dB(A))	338	72	7	(68 - 76)	12	82
RH in workplace (%)	338	52	7	(47 - 57)	48	52
Temperature in workplace (°C)	338	21	2	(20 - 23)	36	64
Reverberation time in workplace (s)	248	1.82	1.79	(0.91 – 2.01)	6	94
Noise outside school (dB(A))	12	74	7	(69 - 80)	100	Not applicable

SD=Standard deviation, RH=Relative humidity

Table 3 Relationships between self-report and objective measures of physical work-related factors in 12 public schools in Bogotá D.C., Colombia

	Self-reported work-related factors		Difference	
Objectively measured work-related factors	**Uncomfortable**	**Comfortable**	**Mean**	**SD**
Noise outside school (dB(A))	73	72	1	12
Background noise in workplace (dB(A))	71	70	1	14
Reverberation time in workplace (seconds)	1.84	1.74	0.10	3
Humidity in workplace (RH)	51	50	1	15
Temperature in workplace (°C)	22	22	0	5

SD=Standard deviation, RH=Relative humidity

Table 4 Associations between work-related factors and presence of voice symptoms in 12 public schools in Bogotá D.C., Colombia

	Crude analysis		Multivariate analysis[$] Objective measures		Multivariate analysis[$] Self-reports		Multivariate analysis[$] Full model	
Work-related factors	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Objectively measured work-related factors								
High noise outside school (dB(A))	1.88*	(1.19 - 2.95)	1.91*	(1.19 - 3.08)			1.83*	(1.12 - 3.00)
High background noise in workplace (dB(A))	0.90	(0.55 - 1.46)						
Long reverberation time in workplace (seconds)	1.03	(0.69 - 1.54)						
High humidity in workplace (RH)	0.95	(0.62 - 1.44)						
High temperature in workplace (°C)	0.91	(0.63 - 1.32)						
Self-reported work-related factors								
High noise in workplace	1.90*	(1.35 - 2.67)			1.33	(0.91 - 1.95)	1.34	(0.92 - 1.95)
Poor acoustics in workplace	2.44*	(1.73 - 3.45)			2.33*	(1.60 - 3.39)	2.34*	(1.61 - 3.41)
Dry air in workplace	1.35+	(0.96 - 1.89)			1.20	(0.82 - 1.74)		
Large changes in temperature in workplace	1.37+	(0.99 - 1.90)			1.04	(0.71 - 1.50)		

* p<0,05

+p<0,20, considered for inclusion in the multivariate logistic regression analysis

[$] adjusted for sex, age, level of education, respiratory diseases, gastrointestinal diseases and hearing impairment.

OR=Odds ratio, CI=Confidence interval, RH=Relative humidity

Chapter 5

Work-related determinants of voice complaints among school workers: An eleven-months-follow-up study

Cantor Cutiva, Lady Catherine; Burdorf, Alex

Submitted

ABSTRACT

To determine the natural course of voice complaints among school workers, and to establish the risk factors associated with incidence and recurrence of voice complaints. We conducted a longitudinal study with eleven-months-follow-up among 682 school workers. Participants filled out a questionnaire on individual and work-related conditions and the nature and severity of voice complaints. All participants who provided baseline data were contacted in the eleven-months-follow-up, if they were still working in the school. Short-term environmental measurements of physical work-related factors were conducted during visits at the workplaces. Logistic regression analysis was used to determine associations between work-related factors and voice complaints. We found a high recurrence of voice complaints, a low recovery of 22% and an annual incidence of 44%. A self-reported high noise level at the workplace was associated with the incidence of voice complaints (OR=2.45). Self-reported poor acoustics in the classroom was associated with recurrence of voice complaints (OR=1.76). This unique longitudinal study among school workers presented some indications that poor acoustics and high noise levels at the workplace may contribute to the incidence and recurrence of voice complaints among teachers.

Keywords:

incidence; recurrence; voice complaints; work-related factors

INTRODUCTION

A large number of studies on the occurrence of voice disorders among teachers have been published documenting a wide range of reported prevalence that ranges from 9% [1] to 94% [2]. A recent systematic review identified three important reasons for this large variation [3]. First, studies that used general terms as "voice complaints" reported a higher prevalence than studies with a specific definition of voice disorder. Second, studies that used long recall periods, such as lifetime, resulted in a higher prevalence compared with studies with recall periods as short as the past week. Third, studies that used questionnaires to assess voice disorders reported a higher prevalence than studies with objective examinations of voice functioning by videolaryngoscopy or indirect laryngoscopy [4-6]. Although most of the studies on the occurrence of voice disorders among teachers are based on cross-sectional designs, there is little insight into the natural variation of occurrence of voice disorders among teachers.

With respect to the causes of voice disorders, several studies among teachers have related the occurrence of voice complaints to the presence of work-related factors [3]. These studies have described that teachers who reported in their workplaces high background noise levels (OR=5.18), poor acoustic conditions (OR=2.69), poor ventilation (OR=2.84) or large changes in temperature (OR=1.48) had more often voice complaints than teachers who did not report these conditions [7-9]. However, this evidence is based on cross-sectional designs that do not allow statements about causality. A second drawback of these studies is that none of these studies have objectively quantified the work-related factors of interest and relied exclusively on self-reports. Thus, the reported associations may suffer from information bias.

Apart from work-related determinants for voice complaints, several cross-sectional studies have pointed at co-occurrence of voice disorders with other health complaints [7,8,10]. Previous studies involving teachers have reported associations between respiratory diseases, such as allergy and asthma, with voice disorders with ORs ranging from 1.69 [11] to 19.72 [9], suggesting a dusty working environment as common determinant. Gastrointestinal diseases have been associated with voice disorders because backflow of stomach content into the throat could generate damage in the vocal folds. Previous studies involving teachers in Brazil and Spain have shown co-morbidity with ORs ranging from 1.83 [11] to 2.48 [12]. Since hearing problems may cause people to speak loudly (Lombard effect), it has been suggested that hearing problems will be associated with voice disorders [13,14]. Empirical evidence in surveys among teachers in the Netherlands and in Brazil have indeed reported these associations with respective ORs of 1.36 [7] and 2.13 [11]

To our knowledge, previous studies on voice disorders among teachers have entirely relied on cross-sectional designs using self-reports for measuring work-related factors. Therefore, in 2012 we conducted a longitudinal study across one teaching year among Colombian school workers with two aims: 1) to determine the natural course of voice complaints among school workers, and 2) to establish the risk factors associated with incidence and recurrence of voice complaints.

METHODS

Design and Participants

We conducted a longitudinal study with eleven-months-follow-up, reflecting a full teaching year, among school workers (teachers and non-teachers). The Medical Ethics Committee of Universidad del Rosario in Colombia approved the study protocol, and all the participant institutions agreed it. Initial power calculations based on previous research [15] suggested that 440 teachers would be required to detect differences between teachers and non-teachers, namely secretaries, head teachers, librarians. A convenience sampling of 12 primary and secondary schools was selected and invited to participate in this research. After approval of head teachers of these public schools, the principal researcher had individual and group meetings with the school workers (1,449 teachers, and 143 non-teachers) to invite them to participate in this study. Then, school workers who wanted to take part of this research signed an informed consent form before filling out a questionnaire in the first weeks of the new school year. All participants in the baseline were contacted at the end of the school year after eleven-months (November and December of 2012), provided that they were still working in the school. Design of the study and sampling procedures have been described in more detail in previous publications [16,17]. Specific results on the cross-sectional data of this research have been presented in previous publications [16,17] or are under-review [18,19]. This work is focused on the longitudinal part of the study.

Data collection procedures

Two measurements were performed during one school year (eleven-months-follow-up). At the start of the school year (February and March), a baseline measurements were done. The follow-up measurements were performed at the end of the school year (November and December). During the school year, teachers had a three-week break in June and one-week break in October.

Questionnaires at baseline

At the start of the school year (February and March), a baseline questionnaire was administered to 682 school workers (n=621 teachers and 61 non-teachers). The questionnaire consisted of 71 questions for teachers and 63 questions for non-teachers. From the questionnaire for non-teachers, we excluded eight questions on specific teaching-related working conditions, such as years on teaching, grade(s) of teaching, classroom(s) number where teaching, number of students per class, hours of teaching per week, subject(s) of teaching, intensive voice use during teaching, and microphone use during teaching. The questionnaire was based on previously used questionnaires [1,7,20], and designed in a way to allow us collecting data on socio-demographic information, occurrence of voice disorders, individual and work-related factors and their socio-economic consequences. We included also a short survey of 8 questions on

health conditions that have been linked to the occurrence of voice disorders, such as respiratory diseases, gastritis and gastroesophageal reflux, and hearing impairment [7,11,12]. More detailed information on the questionnaire has been presented in previous publications [16,17].

Questionnaires at eleven-months-follow-up

At the end of the school year (November and December), participants completed a reduced version of the questionnaire offered at baseline. This questionnaire consisted of 52 questions for teachers and 50 questions for non-teachers. Questions on sex, age, education, lifestyle habits (smoking, alcohol consumption, etc.) and work-related factors (grade(s) of teaching, number of students per class, noise conditions, acoustic conditions, temperature conditions, etc.) were not included in this second questionnaire.

Voice complaints

In this study, the occurrence of voice complaints was determined by the dichotomous question "Have you had voice symptoms in the past month?" [1,20].

At baseline, we calculated the prevalence of voice complaints; and at eleven-months-follow-up, we calculated prevalence, incidence, recurrence and recovery of voice complaints. Prevalence was defined as a report of voice complaints in the past month. An incident case was defined as a subject who reported no voice complaints in the baseline questionnaire and indicated the presence of voice complaints at the eleven-months-follow-up. Recurrence was defined as the presence of voice complaints in the two subsequent questionnaires, which includes cases with chronic complaints being present during the complete follow-up period and cases with intermittent complaints during follow-up but presence of complaints in both questionnaires. Recovery was defined as a subject who reported voice complaints in the baseline questionnaire and no voice complaints at the eleven-months-follow-up. This includes both cases whose complaints had recovered completely as well as cases who had intermittent complaints that were not present at follow-up.

Self-report of work-related factors

The information collected in the fourth part of our questionnaire was used to characterize four physical work-related factors: high background noise in workplace, poor acoustics in workplace, dry air in workplace, and large changes in temperature in workplace. For each question, a 4-point categorical answering scale was used: always, often, sometimes or never. Since the frequency of answers for some categories was low, for further analysis dichotomous variables were used with subjects who answered "always" or "often" regarded as those who perceived their physical working

conditions as being strenuous.

Objective environmental measures

We conducted objective measures of background noise levels (BNL), temperature, humidity, and reverberation time (RT) at the workplaces, such as classrooms and offices. In addition, we measured sound levels (SL) outside schools. The measurements of BNL, temperature and humidity were performed during actual working activities. The measures inside the workplaces were performed at three different locations to cover the complete workplace. The measurements of sound levels outside the schools were targeted at identifying the highest noise level at a distance of 2 meters from walls [21] for each separate school in our sample, thus, presenting a common value for each worker at a particular school. We used the 4 in 1 digital multi-function Environment-Meter Mod WK040 to measure BNL, SL, temperature, and humidity. We measured RT into non-occupied workplaces during weekends or non-lectures times. The software Room Acoustic Measurement System was used to measure RT. For further analyses, we calculated the average value of the measures performed at three different locations. In all statistical analyses, objective measures of environmental factors were dichotomized, whereby subjects under the 75th quartile were used as reference group. The objective environmental measurements are described in detail in a previous publication [17].

Statistical Analysis

For data entry, we used Epi-info 3.5.3. (CDC/2011) software; and SPSS 20 software was used for statistical analysis. At baseline, we used descriptive statistics to characterize the study population. Multiple imputation was performed because some independent variables had a few missing values. Since teachers could work in more than one classroom at their school, we calculated the average value of all environmental measures across all their classrooms within that school as exposure measure per teacher [17]. We used multiple logistic regression analysis to investigate associations between voice complaints (dependent variable) at eleven-months-follow-up with objectively-measured work-related factors, self-reported work-related factors, socio-demographic characteristics and health conditions (independent variables). Of these independent variables, those with a p-value no higher than 0.20 in the univariate analysis were included in the multivariate analyses in order to avoid residual confounding [22], and were only retained if the p-value reached the conventional level of significance of 0.05. All multivariate models were adjusted for sex and age, independent of level of statistical significance, and statistically significant covariates. The magnitude of the associations was expressed as the odds ratio (OR), and the statistical significance as the 95% confidence interval (95% CI). Separate models were established for onset of voice complaints (incident cases) and recurrence of voice complaints with those workers who remained free of voice complaints as reference group in both analyses.

RESULTS

Participant characteristics

At baseline, a total of 682 school workers (n=621 teachers and 61 non-teachers) participated in this study. Overall, 70% of school workers (72% of teachers and 51% of non-teachers) agreed to continue participating in this study at eleven-months-follow-up. Non-response at follow-up was not influenced by socio-demographic factors or presence of voice complaints. These population provide the complete dataset of 480 school workers (n=449 teachers and 31 non-teachers). As shown in Table 1, around 70% of the participating school workers were female and 63% were younger than 50 years of age. There were no differences in socio-demographic characteristics between teachers and non-teachers.

A high proportion of participants reported high background noise levels (66%) and poor acoustic conditions (61%) at the workplace. Both work-related factors were related (Spearman's rho correlation coefficient=0.21, $p < 0.001$). About 49% of school workers reported dry air and 55% of participants reported changing temperatures in workplaces (Spearman's rho correlation coefficient=0.18, $p < 0.001$).

Occurrence of voice complaints during eleven-months-follow-up

As shown in Table 2, the prevalence of voice complaints decreased slightly during the eleven-months-follow-up (71% at baseline vs. 68% at follow-up), but this change was not statistically significant. Moreover, we found a high recurrence of voice complaints with 78% of workers with voice complaints at baseline also reporting voice complaints at follow-up, indicating the persistence presence of these complaints. However, the episodic nature of voice complaints was also demonstrated by a recovery of 22% and an annual incidence of 44%.

Risk factors of voice complaints

Table 3 shows the risk factors for the incidence of voice complaints (n=61) among all workers free of voice complaints at baseline (n=140). In the univariate analysis self-reported high noise levels at the workplace was associated with the incidence of voice complaints. This association changed little after adjustment for important covariates (OR=2.51). After adjustments, socio-demographic characteristics, self-reported health conditions and objectively measured physical conditions at the workplace were not associated with incidence of voice complaints.

Table 4 shows the risk factors for recurrence of voice complaints (n=266) among all workers who also reported voice complaints at baseline (n=340). Self-reported poor acoustics in the classroom was associated with recurrence of voice complaints, and this association changed little after adjustment (OR=1.80). Age, objective measurements of high noise outside the school and high humidity at the workplace were asso-

ciated with a reduced likelihood of recurrent voice complaints. In the univariate analyses level of education, being a teacher, and self-reported respiratory diseases were associated with an increase likelihood of recurrent voice complaint. However, after adjustment these associations were no longer statistically significant.

DISCUSSION

The aim of this longitudinal study was to determine the natural course of voice complaints among school workers, and to establish the risk factors associated with incidence and recurrence of voice complaints during eleven-months-follow-up. There were three main findings in this study. Firstly, the prevalence of voice complaints was high at baseline and consistent during follow-up. Secondly, self-reported high background noise levels in the workplace was an important risk factor for incidence of voice complaints at follow-up. Thirdly, self-reported poor acoustics in the workplace was a risk factor significantly associated with recurrence of voice complaints at follow-up.

Our results suggest that voice complaints are persistent health problems among teachers, due to either their chronicity or their episodic nature, reflected in a high prevalence and recurrence. The prevalence of self-reported voice complaints in the past month was 71% at the start of the study and 68% at eleven-months-follow-up. The slight decrease in prevalence was not caused by selective non-response in this study. The recurrence of voice complaints in the study population was high, whereby 78% of all subjects reported the presence of voice complaints in the past month both at baseline and at follow-up. At the same time, the estimated recovery from voice problems was low (22%). Since all evidence on occurrence of voice disorders among school workers is based on studies with a cross-sectional design [3], it is not possible to compare our results on recurrence and recovery of voice complaints. Our results indicate that voice complaints are persistently presented among school workers of which 91% were teachers. These findings also suggest that most teachers with voice complaints remain at work as much as possible [23,24], since otherwise we would not have observed such a high prevalence and recurrence.

The high incidence of voice complaints also indicates the episodic nature of these complaints. This may be partly due to the use of a short recall period of one month relative to the follow-up period of 11 months, which coincided with a school year. In order to gain more insight into the persistent and episodic nature of voice complaints, it is advised in future studies to separate chronic complaints from acute complaints and to distinguish between risk factors for onset of voice symptoms and prognostic factors for aggravation of voice symptoms.

The main finding of this study was that self-reported high background noise levels at the workplace seems a risk factor for incidence of voice complaints, and self-reported poor acoustic conditions at work seems a risk factor for recurrence of voice complaints. Previous studies showed associations between physical conditions, such as noise and acoustics and self-reported voice complaints [6-8]. Nevertheless, since these

studies were based on cross-sectional designs and their results relied on self-reports of physical conditions, statements about the causality of the associations are not allowed. In our longitudinal study, the presented associations between self-reported poor physical conditions at baseline and incidence and recurrence of voice complaints at follow-up could still be attributed to common method bias due to using a questionnaire [25]. The observed associations between self-reported work-related factors and voice complaints may be due to reporting bias, i.e. those with voice complaints are more sensitive to their working conditions and, consequently, overreport the presence of strenuous physical conditions. Since the observed associations in this longitudinal study were also present at baseline (results not shown), we cannot rule out the possibility that reporting bias partly explained the presented associations.

The objectively measured physical conditions were not associated with incidence and recurrence of voice complaints at follow-up. Several reasons may explain this lack of associations. First, the physical conditions were short-term measurements on a single day. The results may not necessarily reflect well the average conditions encountered by teachers during their school year. Second, the high recurrence of voice complaints in the study population reduced the discriminatory power of the study to identify risk factors for onset of voice complaints. Third, the frequency of exposure was much lower for objectively measured physical conditions than for self-reported conditions (see table 1), indicating systematic differences between both methods. Fourth, the lack of association may also point towards highly varying individual sensitivity whereby some teachers will experience already voice complaints at much lower levels of exposure to environmental risk factors than others.

A few limitations of this longitudinal study must be acknowledged. First, there was a considerable dropout (30%) during the follow-up. However, the non-response at follow-up has most likely not biased the findings, because there was no association between response at follow-up and voice complaints at baseline. Second, the objective measurements only covered a small, single period of the exposure duration of the study population. Thus, these measurements may be a poor proxy of exposure of teachers who experience variable physical conditions during their school year.

In conclusion, this unique longitudinal study across one school year among school workers presented some indications that poor acoustics and high noise levels at the workplace may contribute to the incidence and recurrence of voice complaints among teachers. However, these associations were based on self-reports and could not be corroborated by objective measurements of physical conditions at the workplace. There is a clear need for longitudinal studies that differentiate between onset and aggravation of voice symptoms and that objectively quantify strenuous working conditions repeatedly during the school year.

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Table 1. Socio-demographic characteristics, health conditions and work-related factor of school workers at baseline in 12 public schools in Bogotá D.C., Colombia

	School workers (n=682)	
Variable	**N**	**%**
Socio-demographics		
Female gender	478	70
< 50 years of age	428	63
Teaching occupation	621	91
Level of Education		
Postgraduate studies	198	29
High school and Bachelor	237	35
Other levels of education	247	36
Self-reported health conditions		
Respiratory diseases	255	37
Gastrointestinal diseases	333	49
Hearing Impairment	200	29
Self-reported work-related factors		
High Noise in workplace	447	66
Poor acoustics in workplace	417	61
Dry air in workplace	333	49
Large changes in temperature in workplace	374	55
Objectively measured work-related factors		
High noise outside school (≥80dB(A))	133	20
High Background Noise in workplace (≥76dB(A))	106	16
Large Reverberation Time in workplace (≥2 seconds)	214	31
High humidity in workplace (≥57 % Relative Humidity)	135	20
High temperature in workplace (≥23 °C)	207	30

Table 2. Occurrence of voice complaints at baseline and at eleven-months-follow-up among school workers (n=480) in 12 public schools in Bogotá D.C., Colombia

	School workers			
	Baseline 95% CI (n=480)		1st Follow-up 95% CI (n= 480)	
Voice complaints in the past month	N	%	n	%
Prevalence	340	71 (67-75)	327	68 (64-72)
Incidence	-	-	61	44 (36-52)
Recurrence	-	-	266	78 (74-82)
Recovery	-	-	74	22 (18-26)

Table 3 Risk factors for incidence of voice complaints among school workers (n=61) during an eleven-months-follow-up in 12 public schools in Bogotá D.C., Colombia

	Crude analysis		Multivariate analysis Objective measures		Multivariate analysis Self-reports		Multivariate analysis Full model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Socio-demographics								
Female gender	1.86+	(0.91 - 3.77)	1.97	(0.90 - 4.30)	1.92	(0.87 - 4.25)	1.80	(0.80 - 4.02)
50 or more years of age	0.54+	(0.27 - 1.07)	0.62	(0.26 - 1.44)	0.58	(0.24 - 1.39)	0.58	(0.24 - 1.39)
Postgraduate studies	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
High school and Bachelor	0.63	(0.26 - 1.54)	0.71	(0.27 - 1.87)	0.62	(0.23 - 1.68)	0.66	(0.24 - 1.78)
Other levels of education	0.34*	(0.13 - 0.89)	0.45	(0.15 - 1.35)	0.44	(0.15 - 1.34)	0.47	(0.15 - 1.48)
Teaching occupation	0.46+	(0.14 - 1.52)	0.36	(0.10 - 1.36)	0.27	(0.06 - 1.12)	0.31	(0.08 - 1.25)
Self-reported health conditions								
Respiratory diseases	2.12+	(0.98 - 4.59)	1.59	(0.68 - 3.75)	1.72	(0.70 - 4.22)	1.69	(0.68 - 4.19)
Gastrointestinal diseases	0.86	(0.40 - 1.84)						
Hearing Impairment	1.54	(0.59 - 4.03)						
Objectively Measured Work-related factors								
High noise outside school (dB(A))	1.88	(0.57 - 6.25)						
High Background Noise in workplace (dB(A))	0.44+	(0.16 - 1.24)	0.55	(0.19 - 1.64)			0.51	(0.17 - 1.54)
Large Reverberation Time in workplace (seconds)	1.02	(0.42 - 2.46)						
High humidity in workplace (RH)	0.97	(0.35 - 2.69)						
High temperature in workplace (°C)	1.77+	(0.77 - 4.11)	1.26	(0.52 - 3.07)			1.17	(0.46 - 2.98)
Self-reported Work-related factors								
High Noise in workplace	2.37*	(1.14 - 4.96)			2.45*	(1.08 - 5.55)	2.51*	(1.09 - 5.77)
Poor acoustics in workplace	1.24	(0.60 - 2.57)						
Dry air in workplace	1.14	(0.57 - 2.31)						
Large changes in temperature in workplace	1.57	(0.78 - 3.14)						

* $p<0.05$

+$p<0.20$, considered for inclusion in the multivariate logistic regression analysis

Table 4 Risk factors for recurrence of voice complaints among school workers (n=266) during an eleven-months-follow-up in 12 public schools in Bogotá D.C., Colombia

	Crude analysis		Multivariate analysis Objective measures		Multivariate analysis Self-reports		Multivariate analysis Full model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Socio-demographics								
Female gender	1.20	(0.66 - 2.18)	1.14	(0.60 - 2.19)	1.20	(0.62 - 2.29)	1.21	(0.63 - 2.32)
50 or more years of age	0.61+	(0.35 - 1.08)	0.65	(0.35 - 1.20)	0.64	(0.34 - 1.21)	0.67	(0.35 - 1.27)
Postgraduate studies	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
High school and Bachelor	1.63+	(0.77 - 3.44)	1.46	(0.66 - 3.20)	1.43	(0.66 - 3.10)	1.42	(0.64 - 3.15)
Other levels of education	1.96*	(1.00 - 3.87)	1.80	(0.91 - 3.57)	1.83	(0.92 - 3.64)	1.72	(0.86 - 3.45)
Teaching occupation	2.41+	(0.80 - 7.29)	1.90	(0.58 - 6.19)	1.99	(0.61 - 6.51)	1.78	(0.52 - 6.06)
Self-reported health conditions								
Respiratory diseases	1.56+	(0.90 - 2.71)	1.68	(0.93 - 3.01)	1.62	(0.91 - 2.89)	1.69	(0.94 - 3.04)
Gastrointestinal diseases	1.24	(0.74 - 2.07)						
Hearing Impairment	1.08	(0.61 - 1.92)						
Objectively Measured Work-related factors								
High noise outside school (dB(A))	0.56*	(0.32 - 1.00)	0.58	(0.32 - 1.05)			0.57	(0.31 - 1.03)
High Background Noise in workplace (dB(A))	0.67	(0.33 - 1.37)						
Large Reverberation Time in workplace (seconds)	0.81	(0.39 - 1.68)						
High humidity in workplace (RH)	0.54*	(0.29 - 1.00)	0.61	(0.32 - 1.16)			0.60	(0.31 - 1.15)
High temperature in workplace (°C)	1.15	(0.61 - 2.14)						
Self-reported Work-related factors								
High Noise in workplace	1.04	(0.60 - 1.79)						
Poor acoustics in workplace	1.83*	(1.07 - 3.14)			1.76*	(1.01 - 3.06)	1.80*	(1.03 - 3.16)
Dry air in workplace	1.07	(0.64 - 1.79)						
Large changes in temperature in workplace	0.81	(0.47 - 1.41)						

* p<0.05

+p<0.20, considered for inclusion in the multivariate logistic regression analysis

Chapter 6

Factors associated with voice-related quality of life among teachers with voice complaints

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ABSTRACT

This study evaluates whether the scores on the Voice-Related Quality of Life (V-RQOL) and Voice Activity and Participation Profile (VAPP) instruments show similar associations with socio-demographic characteristics, voice complaint characteristics, work-related factors, health conditions and consequences of voice complaints; and to assess agreement between primary and secondary public ducted a cross-sectional study teachers with voice complaints. Participants filled out a questionnaire on socio-demographic characteristics, voice complaint characteristics, work-related factors, health conditions, economic consequences of voice complaints, and voice-related quality of life, which was assessed using the V-RQOL and the VAPP. The factors associated with the scores on the V-RQOL and VAAP were analysed using multiple linear regression. Assessment of agreement between the V-RQOL and VAPP scores was performed using the Bland-Altman plot. Simple linear regression analysis was used to examine the relationship between VAPP and V-RQOL. Results showed that individual and work-related factors that were associated with the scores derived from the questionnaires were similar for the two instruments, namely severity of voice complaints, auditory symptoms, hearing impairment, class size, and poor acoustics in the workplace. The associations between the score and the economic consequences of voice complaints were also similar for the two instruments. The V-RQOL and VAPP scores were strongly associated with one another and showed high agreement with regard to teachers' perception of quality of life. These findings suggest that factors identified as being associated with the scores on the V-RQOL and VAPP are shared by the two instruments, showing that their approaches to quality-of-life assessment are similar. Both scales were strongly associated with one another and showed high agreement.

Keywords:

Voice-Related Quality of life; Voice Activity and Participation Profile; voice complaints; teacher

INTRODUCTION

Teachers have been recognized as one of the largest group of "professional voice users" [1]. Previous research has shown that voice complaints are more prevalent among teachers than in other occupational groups [2], with reported prevalence ranging from 9% [3] to 94% [4]. Since teachers use their voice as a primary tool of work, voice complaints may have a greater impact on their quality of life [5-9].

To assess the impact of voice complaints on quality of life, several health-related questionnaires have been developed. Two of the most commonly used questionnaires are the Voice-Related Quality of Life (V-RQOL) and the Voice Activity and Participation Profile (VAPP). Three studies in teachers have reported using the V-RQOL [8,10,11] and two have reported using the VAPP [6,12]; only one publication expressed a preference for one of them (VAPP) [12]. With regard to the results of these studies, one of the studies that used the V-RQOL reported the perception of quality of life to be 23% higher among teachers without voice complaints than in those with voice complaints [10]. Another study using the VAPP showed that teachers with voice complaints reported much higher summary scores than those without voice complaints, reflecting a 41% reduction in quality of life [6]. From these two examples we can see that the scoring systems and interpretation of the scores are different for the V-RQOL and the VAPP. However, these two instruments have been used interchangeably to assess quality of life among teachers with voice complaints [13,14].

These differences may originate in the conceptual definition adopted by each questionnaire. The V-RQOL is focused on an integrated assessment of functioning in relation to individual and environmental factors, whereas the VAPP addresses primarily specific limitations in activities and participation. For example, the V-RQOL includes mental and physical functioning (e.g. "I have trouble speaking loudly or being heard in noisy situations"); whereas the VAPP will ask for the consequences of reducing functioning for social participation (e.g. "Does your voice problem affect your communication in noisy environments?"). The International Classification of Functioning makes a clear distinction between the two, whereby associations between functioning, limitations and participation may be modified by environmental and personal characteristics [15]. Hence, although both instruments assess functioning, they may present different outcomes with respect to the environmental and individual factors that are associated with the impact of voice complaints on quality of life.

Nevertheless, little has been published on the associations between the scores of the V-RQOL and the VAPP instruments and the socio-demographic characteristics, voice complaint characteristics and consequences of voice complaints. Furthermore, the few studies that have looked at these relationships have shown ambiguous results. While some researchers have shown similar relationships between the scores of the V-RQOL or the scores of the VAPP and socio-demographic characteristics, voice complaint characteristics or consequences of voice complaints [6], other studies have failed to corroborate these relationships [8]. Bermudez de Alvear et al (2009) suggested that voice-related quality of life in teachers with voice complaints differed according to

socio-demographic characteristics (such as gender) (X^2=7.80; p<0.01), voice symptoms characteristics (e.g. duration of voice symptoms) (X^2=22.56; p<0.01) and consequences of voice symptoms (e.g. voice-related absenteeism) (X^2=8.62; p<0.01). In contrast, Grillo et al (2005) showed that the scores of the V-RQOL were not associated with age (r=-0.03; p>0.05), nor with work-related factors such as years of teaching (r=-0.17; p>0.05) and working hours per day (r=-0.08; p>0.05). To our knowledge, there is a lack of research examining determinants of voice-related quality of life, research that is important for a better understanding of the perspective of teachers with regard to their voice complaints.

With respect to the instruments used in such research, since questionnaires to assess quality of life among teachers are health related but not occupation related [13], it is important to know which questionnaire best reflects the impact on quality of life in teachers with voice complaints or whether they are interchangeable. This requires an analysis of whether the scores on both instruments are influenced by the same factors, and an assessment of agreement between the two instruments.

To address these issues, we conducted a cross-sectional study of 438 Colombian teachers with self-reported voice complaints. Our aims were to evaluate whether the scores of the V-RQOL and the VAPP show similar associations with socio-demographic characteristics, voice complaint characteristics, work-related factors of voice complaints, health conditions, and economic consequences of voice complaints, and to assess agreement between the V-RQOL score and the VAPP score.

METHODS

Design and participants

We conducted a cross-sectional study in public schools in Bogotá, Colombia in February and March 2012 (at the start of the school year). The initial power calculations showed that a prevalence ratio of 1.5 between teachers and non-teachers could be demonstrated with 440 teachers in the study population, assuming a 12-month prevalence of voice complaints among teachers of 34% [7], a power of 80%, and statistical significance of 0.05. The Department of Education of Bogota selected by convenience sampling 12 primary and secondary schools, among the 358 public schools that they manage, to participate in this research (n=1,446 teachers). The principal researcher had group and individual meetings with the head teachers of those schools to describe the purpose and requirements of the study and to invite them to participate. Initial contact with teachers was made through visits to the schools during breaks between classes, at the end of classes, or during teachers' meetings. Teachers were informed about the aims of the study and the voluntary and confidential nature of participation. Then, teachers who were interested in participating in the study signed the informed consent form before filling out a questionnaire. In total, 621 teachers participated in this research, 438 of whom had self-reported voice complaints and who therefore made up the study population. The study protocol was agreed by the

Department of Education of Bogotá, the Universidad del Rosario in Bogota, and Erasmus University Medical Center in Rotterdam. The study was approved by the Medical Ethics Committee of the Universidad del Rosario in Colombia, and complied with the ethical principles embodied in the Declaration of Helsinki.

Data collection procedures

Questionnaire

For this study we developed a questionnaire that was based on existing English-language questionnaires described in the literature [3,16,17] and consisted of 71 questions. Since the questionnaire was based on English sources and the official language in Colombia is Spanish – and we wanted to be sure that the interpretation of terms and phrases was conceptually equivalent – the questionnaire was translated English-Spanish-English. The English-Spanish translation was done by the first author and the Spanish-English translation was done by a colleague.

The first part of the questionnaire contained questions about sex, age, and education. Since menopause-related hormonal changes that affect the voice of both men and women start around the age of 50 [18], in further analysis the variable age was dichotomized using a cut-off vale of 50 years of age.

The second part of the questionnaire contained questions about the presence of voice symptoms in the past month; the frequency, severity and duration of these symptoms; whether the voice was affected while singing or speaking; the aggravation of voice symptoms at work over time; and improvements during non-work periods (weekends, holidays).

The third part contained questions about lifestyle habits known to be associated with voice complaints [16,19,20]. The fourth part contained questions about working conditions [21], including 5 questions about work-related factors, such as noise, acoustic conditions, temperature, humidity and dust. With regard to these physical factors, participants were asked to indicate whether they considered them uncomfortable: always, often, sometimes or never. Since the frequency of answers for some categories was low, in further analysis exposure to physical factors was considered a dichotomous variable, with subjects who answered "always" or "often" considered as being exposed. We also included questions on class size and years in teaching. For these variables, median values were taken as cut-off.

The fifth part consisted of the Voice Activity and Participation Profile (VAPP) [22] and the sixth part contained the Voice-Related Quality of Life (V-RQOL) [23]. The Spanish adaptations of the VAPP and the V-RQOL that we constructed for this study have not yet been published.

The final part of the questionnaire contained questions regarding health-care use,

voice-related absenteeism and productivity loss due to voice complaints. Health-care use was assessed using the dichotomous question: “Have you sought medical care regarding your voice disorder during the past month?” Participants were also able to indicate which health professional they had consulted regarding their voice complaints [24]. Voice-related absence from work was assessed using the dichotomous question: “Have you been absent from work during the past month because of voice disorders?” Participants were also able to indicate how many work days in total they had been absent from work in the past month [3]. Information regarding productivity loss due to voice complaints in the past month was assessed using the following questions: “In the past month, how much has your voice disorder interfered with your work productivity on a scale of 0-10, where 0=”no interference” and 10=”complete interference”?” [25] and “How many days in the past month did you work while you had voice disorders?” [26].

Voice Activity and Participation Profile (VAPP)

The VAPP consists of 28 questions on limitations in activities and reduced willingness to participate in voice-related activities, and covers the following five domains: severity of voice problems (n = 1), effects on the job (n = 4), effects on daily communication (n = 12), effects on social communication (n = 4) and effects on emotions (n = 7) [22]. Each question is rated according to a five-point scale: Never (0), almost never (1), sometimes (2), almost always (3), and always (4). We selected the five-point rating scale instead of the visual analogue scale because it takes less time to analyse and previous studies have shown no differences in the results of the VAPP when different rating scales are used [27]. We calculated a sum score across all items, ranging theoretically from 0 to 112. This sum score was subsequently converted to a scale ranging from 0 (poorest) to 100 (highest) quality of life in order to enable direct comparison with V-RQOL.

Voice-Related Quality of life (V-RQOL)

The V-RQOL consists of six questions on physical functioning in the past two weeks and four questions on mental functioning in the past two weeks. Physical functioning relates to trouble while speaking, using the telephone or during working. Mental functioning refers to symptoms of anxiety and depression and to withdrawal from friends. Each statement is scored on a five-point scale to indicate whether an aspect of functioning is not a problem (1), experienced a small amount (2), a moderate (medium) amount (3), a lot (4), or the problem is as “bad as it can be” (5). A sum score ranging from 10 to 50 was calculated and subsequently rescaled from zero (poorest) to 100 (best), with higher scores indicating a better voice-related quality of life [23].

Voice complaints

The information collected in the second part of our questionnaire was used to establish the presence and characteristics of voice complaints. The presence or absence of voice complaints was determined using the dichotomous question "Have you had voice symptoms in the past month?" [3,16]. For 11 symptoms, participants were also able to indicate how many and what kind of symptoms they had had in the past month. For further analysis, we classified these voice symptoms into sensory and auditory symptoms. Sensory symptoms included tired voice, vocal fatigue, dry throat, itchy sensation, and pain in throat. Auditory symptoms were hoarseness, weak voice, voice spasms, voice loss, strained voice, and breathiness [28]. Participants rated the severity of their voice symptoms (mild – moderate – severe) and mentioned how long their voice symptoms had lasted. Since the frequency of answers was very low for some categories, for further analysis dichotomous variables were used for severity (mild versus moderate-severe) and duration (5 days or less versus 6 days or more).

Health-related conditions

Previous studies in teachers have found associations between voice complaints with respiratory diseases [6,29], gastrointestinal diseases [29,30] and hearing problems [17,29]. Since these three health conditions have been found to be associated with the occurrence of voice complaints, we included five questions on the presence of respiratory allergies, asthma, gastritis, gastro-oesophageal reflux, and hearing impairment.

Statistical Analysis

Epi Info 3.5.3 (CDC/2011) software was used for data entry, and SPSS 20 software was used for statistical analysis. Descriptive statistics were used for characteristics of the study population.

Firstly, we used linear regression to investigate associations between the V-RQOL score or the VAPP score and self-reported voice complaint characteristics, socio-demographic characteristics, work-related factors, and health-related conditions. In separate models, we studied the associations between V-RQOL or VAPP and economic consequences (expressed as productivity loss at work, voice-related absenteeism and use of health-care services). For the independent variables, those with a p-value no higher than 0.20 in the univariate analysis were included in the multivariate analyses in order to avoid residual confounding [31], and were only retained if the p-value reached the conventional level of significance of 0.05. The magnitude of the associations was expressed as the odds ratio (OR), and the statistical significance as the 95% confidence interval (95% CI).

Secondly, we assessed the agreement between the V-RQOL and VAPP scores using the Bland-Altman Plot, which is preferred above a simple correlation, since it shows the

agreement across the complete range of observed values and can identify systematic error relative to the measurement value. The Bland and Altman method calculates the mean difference between two methods of measurement and 95% limits of agreement around the mean difference [32]. The presentation of the 95% limits of agreement is for visual judgement of how well two methods of measurement agree. The smaller the range between these two limits, the better the agreement [33]. Simple linear regression analysis was used to examine the relationship between VAPP (*x*) and V-RQOL (*y*).

RESULTS

Participant characteristics

As shown in Table 1, around 57% of the teachers were younger than 50 years, and most teachers were female (76%). About 52% of the teachers had been teaching for less than 20 years, and 86% of the teachers had more than 30 students per class. Most teachers reported self-perceived productivity loss in the past month due to their voice complaints (69%), around 25% reported having sought medical care for their voice complaints, and 7% reported voice-related absenteeism in the past month.

Factors associated with scores on V-RQOL and VAPP scales

Tables 2 and 3 show those factors that were found to be associated with the V-RQOL and VAPP scores in univariate and multivariate linear regression analyses. The results of the multivariate analysis in Table 2 show that following adjustment for all variables that were statistically significant in the univariate analysis, the quality-of-life scores on the V-RQOL and the VAPP were significantly lower for 5 groups of teachers: those who reported moderate-severe voice complaints (β= -13.40 for V-RQOL; β= -11.27 for VAPP), auditory symptoms (-8.30; -5.65), hearing impairment (-7.26; -4.98), higher class size (-7.15; -4.87;), and poor acoustics in the workplace (-4.99; -4.97). For the V-RQOL score, a longer duration of voice complaints was also associated with a lower score (β= -5.63).

As shown in Table 3, lower scores on the V-RQOL and the VAPP were significantly associated with health-care use, self-perceived productivity loss at work, and voice-related absenteeism. Among these three factors, the largest reductions in the scores on both instruments were due to productivity loss at work due to voice complaints (β= -12.08 for V-RQOL; β= -12.95 for VAPP), followed by voice-related absenteeism in the past month (-9.26; -9.37) and use of health-care services (-7.39; -6.85).

Agreement between V-RQOL and VAPP scores

The mean score on the V-RQOL was 76.06 with a standard deviation (SD) of 20.42. The mean score on the VAPP was 72.21 with an SD of 18.27. Figure 1 shows the Bland-Altman plot used to assess agreement between the VAPP and the V-RQOL scores. The mean of the differences between the VAPP and V-RQOL scores was -3.28 (SD=13.05). The difference between the two instruments was not associated

with the average mean, indicating that any systematic bias was constant across all measurement values. The linear regression analysis yielded the equation y = 0.88x + 11.71, suggesting a systematically higher score for V-RQOL (11.71) and a high correlation between both instruments (regression coefficient = 0.88).

DISCUSSION

In this study, we investigated the associations between the V-RQOL score or the VAPP score and socio-demographic characteristics, voice complaint characteristics, work-related factors, health-related conditions and economic consequences of voice complaints. In addition, we assessed agreement between the V-RQOL score and the VAPP score. Our findings showed that the socio-demographic characteristics, voice complaint characteristics, work-related factors and health-related conditions of voice complaints identified as being associated with the scores on the V-RQOL and the VAPP are similar, namely severity of voice complaints, auditory symptoms, hearing impairments, class size, and poor acoustics in the workplace. Both instruments also showed similar associations with the economic consequences of voice complaints, namely health-care use, self-perceived productivity loss at work, and voice-related absenteeism in the past month. The V-RQOL and VAPP scores were strongly associated with one another and showed high agreement with regard to self-perception of quality of life among teachers with voice complaints. Only a small difference in average scores between both instruments was observed (5% of the mean score). In conclusion, the associations between the scores and environmental and individual characteristics were comparable in both instruments, and they presented very similar assessments of voice-related quality of life.

Since the definition of quality of life in the V-RQOL and the VAPP differ, they partly reflect different aspects of the impact of voice disorders on quality of life. The V-RQOL is focused on assessing the aspects of functioning, including body functions, activities and participation [23]. Hence, a higher score indicates a lower impact of voice disorders on socio-emotional functioning and physical functioning. The VAPP addresses primarily specific limitations in activities and participation [22]. A higher score of VAPP indicates more restrictions in daily activities or social participation due to voice disorders. Although the VAPP covers a wider range of health and health-related domains than V-RQOL, our findings showed that both measures were associated with similar environmental and individual factors.

Analysis of the factors identified as being associated with both the V-RQOL score and the VAPP score showed that severity of voice complaints was the factor that reduced both scores the most. Teachers with moderate or severe voice complaints had a V-RQOL score that was 18% lower and a VAPP score that was 16% lower than the scores of teachers with only mild voice complaints. This finding is in agreement with previous studies that have shown that the severity of complaints is an important factor associated with a reduced voice-related quality of life [34,35], although it should be noted that this research used a different scale to assess the association between voice-relat-

ed quality of life and perceptual assessment of severity of voice complaints. The association between severity of voice complaints and voice-related quality of life highlights the role of voice in daily participation; hence, moderate-severe voice complaints imply communication difficulties not just at work but also in daily activities.

Self-perceived productivity loss, voice-related absenteeism and health-care use were also associated with lower V-RQOL and VAPP scores. In this study we found, broadly speaking, that teachers who reported these economic consequences of voice complaints also perceived a lower quality of life. Compared with teachers with voice complaints who did not report these economic consequences, quality of life was 16%-18% lower in teachers who perceived productivity loss at work, 12%-13% lower in those with sickness absence in the past month, and 9-10% in those who sought medical care. Our results are in agreement with a previous study whereby female teachers who were absent from work due to voice complaints were twice as likely to have a poor quality of life than female teachers without sickness absence [11]. Since the negative impact of these three consequences of voice complaints on quality of life were similar for both instruments (V-RQOL and VAPP), it seems that both the V-RQOL and the VAPP are comparable when assessing the direct and indirect costs of voice complaints.

We found that both instruments showed high agreement for assessing voice-related quality of life. Although the mean scores of both instruments showed a systematic, but small, difference, the Bland-Altman plot shows that this difference did not vary systematically over the range of the measurements. We also found a strong association between VAPP and V-RQOL scores. This finding is in agreement with one other study that showed that V-RQOL and VAPP are highly correlated, with a Spearman correlation coefficient of -0.89 [13].

In this study, the mean score on the V-RQOL was 76.06 and the median score of the VAPP was 27.68 without inversion of the score. These results suggest that the perceived impact of voice complaints on quality of life in teachers with voice complaints in public schools in Bogotá is modest. Comparable results have been found in another South American country (i.e. Brazil). In a small study among 8 Brazilian college teachers with voice complaints the average perceived quality of life, as measured by the V-RQOL, was about 10% lower than teachers in our study population [10]. In another study 82 Brazilian teachers with voice complaints reported an average VAPP score of 22.3, which indicated at best a 20% better quality of life than Colombian teachers [12]. These modest differences between Brazilian and Colombian teachers may be partly attributed to differences in nature and severity of voice complaints, as well as individual and work-related factors. Comparable information from teachers in other countries is not available in the scientific literature and, hence, it cannot be established whether local and cultural factors have influenced the reported impact of voice symptoms on voice-related quality of life. Another complicating factor in the generalizability of our findings is the organisation of the educational system. Nowadays, one of the biggest challenges in Colombia is to increase the provision of primary and secondary education to all its citizens. As a result, changes in the educational system are implemented

that will extend hours of teaching per day and number of students per class. The latter was identified as a potential determinant of a reduced voice-related quality of life and, thus, these changes may negatively impact on teachers´ working conditions and quality of life.

A major limitation of this study was the cross-sectional study design, which does not allow insight into the causality of the reported associations: we have no information on the relationship over time between the factors identified as being associated and the onset and presence of voice complaints. Another limitation is the reliance on self-reported data for the economic consequences of voice complaints, which was partly due to lack of instruments for objective measurement of productivity loss. A third limitation is a possible influence on the results of the order in which the scales were filled out, since all the teachers completed the VAPP before completing the V-RQOL.

In conclusion, the scores on the V-RQOL and the VAPP were strongly associated and showed a high agreement. Both scales identified the same associated factors showing that their assessments of quality of life were similar. Therefore, we suggest that the results of the V-RQOL and the VAPP in studies on voice-related quality of life are comparable, although they partly reflect different aspects of quality of life.

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Table 1. Characteristics of 438 teachers with voice complaints from 12 public schools in Bogotá, Colombia

Variable	N	%
Socio-demographics		
< 50 years of age	250	57
Female	332	76
Postgraduate studies	123	28
High school and Bachelor	147	34
Other levels of education	159	36
Health-related conditions		
Respiratory diseases	174	40
Gastrointestinal diseases	226	52
Hearing Impairment	147	34
Work-related factors		
High noise in workplace	309	71
Poor acoustics in workplace	291	66
Dry air in workplace	208	47
Changes in temperature in workplace	250	57
Dust in workplace	264	60
≤20 years in teaching	227	52
≥30 students per class	376	86
Self-reported voice complaints		
Sensory symptoms	386	88
Auditory symptoms	381	87
Moderate-severe voice complaints	266	61
More than 5 days with voice complaints	96	22
Consequences of voice complaints		
Sought medical care in the past month	108	25
Prevalence of productivity loss in the past month	304	69
Voice-related absenteeism in the past month	29	7

Table 2. Associations between V-RQOL and VAPP scores and socio-demographic characteristics, work-related factors, health-related conditions and voice complaint characteristics of 438 teachers with voice complaints from 12 public schools in Bogotá, Colombia

	VR-QOL				VAPP			
	Univariate analysis		Multivariate analysis		Univariate analysis		Multivariate analysis	
Variable	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Socio-demographics								
Female gender	-5,21*	2,31	-2,83	2,29	-1,38	2,04	0,18	2,04
Age (years)	-0,07	0,1			-0,06	0,09		
Level of education (low/high)	4,20+	2,25	2,11	2,11	3,79*	1,95	2,76	1,86
Health-related conditions								
Respiratory diseases (yes/no)	-1,86	2,08			-1,47	1,82		
Gastrointestinal diseases (yes/no)	-7,03*	2,04	-3,28	1,94	-4,23*	1,8	-1,32	1,72
Hearing Impairment (yes/no)	-6,69*	2,14	-7,26*	1,99	-4,24*	1,87	-4,98*	1,74
Work-related factors								
High noise in workplace (yes/no)	-4,98*	2,19	-0,69	2,18	-7,25*	1,88	-3,52	1,91
Poor acoustics in workplace (yes/no)	-4,77*	2,17	-4,99*	2,06	-5,91*	1,85	-4,97*	1,83
Dry air in workplace (yes/no)	-0,77	2,07			-1,91	1,74		
Changes in temperature in workplace (yes/no)	-0,01	2,06			-0,36	1,76		
Dust in workplace (yes/no)	-4,12*	2,07	-2,00	2,00	-4,89*	1,76	-2,84	1,76
Years in teaching (≥20 / <20 years)	-1,75	2,02			-0,99	1,75		
Class size (≥30 / <30 students)	-5,37+	2,86	-7,15*	2,72	-5,51*	2,53	-4,87*	2,46
Self-reported Voice Complaints								
Sensory symptoms (yes/no)	-5,45*	3,10	-0,74	3,14	-7,66*	2,68	-5,26	2,77
Auditory symptoms (yes/no)	-13,40*	2,88	-8,30*	2,99	-9,77*	2,56	-5,65*	2,64
Severity of voice complaints (moderate-severe/mild)	-14,98*	1,91	-13,40*	2,11	-13,31*	1,68	-11,27*	1,85
Duration of voice complaints (≥ 5 / <5 days)	-10,97*	2,34	-5,63*	2,27	-7,81*	2,03	-3,47	2,01

* p<0.05

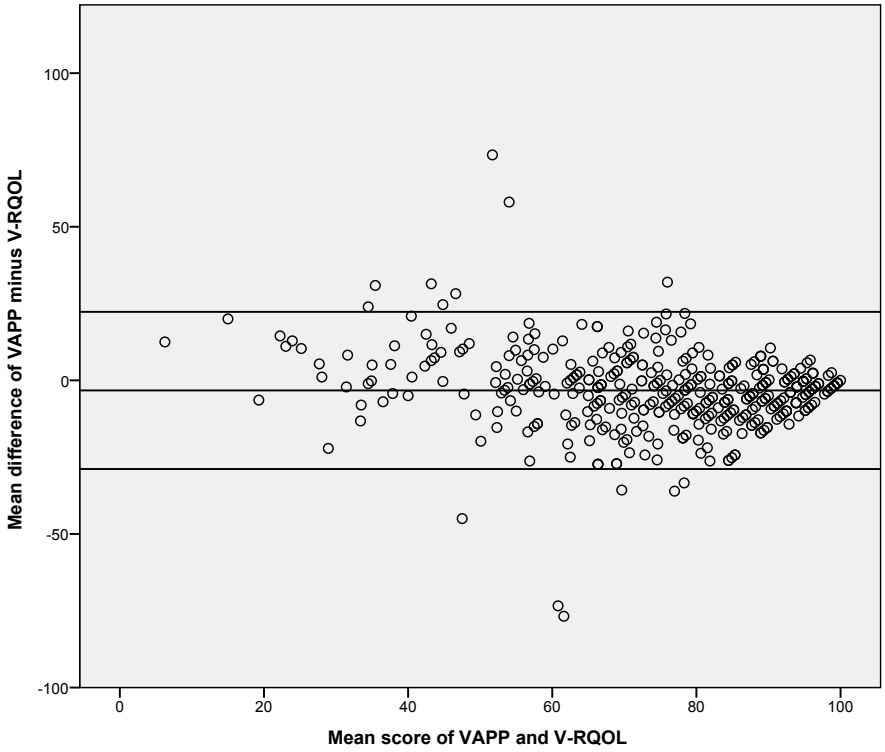
+p<0.20

Table 3. Associations between V-RQOL and VAPP scores with economic consequences of voice complaints in 438 teachers with voice complaints from 12 public schools in Bogotá, Colombia

	VR-QOL				VAPP			
	Univariate analysis		Multivariate analysis		Univariate analysis		Multivariate analysis	
Variable	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Use of health-care services (yes/no)	-12,19*	2,26	-7,39*	2,37	-11,43*	1,92	-6,85*	1,53
Productivity loss due to voice complaints (yes/no)	-13,74*	2,19	-12,08*	2,15	-14,82*	1,82	-12,95*	1,79
Voice-related absenteeism in the past month (yes/no)	-14,41*	3,90	-9,26*	3,89	-14,50*	3,32	-9,37*	3,27

* $p<0.05$

Figure 1. Bland-Altman Plot. Data indicate that VAPP and V-RQOL show a systematic, but small, difference in their mean scores. This difference does not vary systematically over the range of the measurements.



Chapter 7

Medical costs and productivity costs related to voice symptoms in Colombian teachers

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ABSTRACT

To investigate the medical costs and productivity costs of voice symptoms among teachers, and to assess the contribution of the characteristics of voice symptoms, socio-demographic characteristics, health conditions and work-related factors to these costs. In 2012, we conducted a longitudinal study in 12 public schools in Bogotá D.C., Colombia. This study is focused on cross-sectional results obtained in the first stage of the data-collection process. Participants filled out a questionnaire on socio-demographics, voice symptoms, work-related conditions, use of health care, productivity loss at work and sickness absence. Multiple logistic regression analysis was used to explore associations between health care use, voice-related absenteeism and productivity loss with duration and severity of voice symptoms, socio-demographic characteristics, health conditions and work-related factors. In total, 621 Colombian teachers participated in this research, 438 of whom had self-reported voice complaints and who therefore made up the study population. Total medical costs and productivity costs due to presence of voice symptoms among teachers with voice complaints equalled around 37% of their monthly wage. Approximately 3% of the costs were direct costs for health care use and 97% were indirect costs for productivity losses. Severity of voice symptoms was significantly associated with health care use and absenteeism. Voice symptoms among teachers have important economic consequences due to health care use, voice-related absenteeism, and productivity loss at work.

Keywords:

voice symptoms; health care costs; absenteeism; productivity loss; teacher

INTRODUCTION

Various studies have reported a high occurrence of voice disorders among teachers ranging from 9% [1] to 94% [2]. A recent systematic review showed that this large variation could partly be attributed to large differences in criteria for determining the presence of a voice disorder and differences in the established recall periods [3]. Publications that used general terms, such as voice symptoms, reported a higher prevalence of 80% [4] compared with publications using a specific definition of a voice disorder that reported prevalence of 15% [5]. Publications that used longer recall periods, such as lifetime or unspecified recall period, reported a higher prevalence of 94% [2] compared with publications reporting point prevalence of 9% [1]. It is of interest to note that most studies focused on reporting the presence of voice disorders with little attention of severity and duration of these disorders. In addition, there was little information on consequences of voice disorders among teachers for functioning in daily life [6,7].

Few studies have provided information on consequences of voice disorders among teachers for health care use and functioning at work. Two cross-sectional studies reported that teachers had more missed work-days due to their voice symptoms than other occupational groups with odds ratios ranging from 2.98 [2] to 10.31 [8]. In addition, some studies have reported the contribution of several work-related factors to sickness absence [6,9]. Teachers who reported high noise (OR=2.01), poor acoustics (OR=1.53), and dry or moist humidity in their workplaces (OR=1.55) were more likely to miss workdays due to voice symptoms. Two cross-sectional studies also indicated that teachers with voice complaints used health care services more often than non-teachers [7,8]. Health care use may be prompted by severity of voice disorders [7]. This merging evidence is difficult to interpret because most studies on health care use and sickness absence do not distinguish occurrence of voice disorders from its consequences, for example by reporting on determinants of sickness absence due to voice disorders among teachers with and without voice disorders. There is also a lack of studies that systematically evaluate economic consequences of voice disorders for health care use, voice-related absenteeism and productivity loss at work.

In order to address these issues, we conducted a cross-sectional study, as part of a larger longitudinal study, among teachers with voice symptoms in the public school system in Bogotá D.C., Colombia with two aims: 1) to investigate the direct and indirect costs of voice symptoms, in terms of health care use, voice-related absence and productivity loss at work, and 2) to assess the contribution of the duration and severity of voice symptoms, socio-demographic characteristics, health conditions and work-related factors to the direct and indirect costs of these disorders among teachers.

METHODS

This study is part of a larger longitudinal study among teachers in the public school system in Bogotá D.C., Colombia. More detailed information on the sampling process, the questionnaire and the definition of voice symptoms has been described in previous publications [10,11].

Design and Participants

In 2012, we conducted a longitudinal study in 12 public schools in Bogotá D.C., Colombia. This study is focused on cross-sectional results on economic consequences obtained in February and March (at the start of the school year).

After power calculations to determine the minimal sample size required, 12 participant schools were selected by convenience sampling by The Department of Education of Bogota (n=1,446 teachers). After approval by the school board, at each school, group and individual meetings were held to inform the teachers about the general aims of the study. Subsequently, all personnel was asked to participate in the study. Teachers who decided to take part in this study filled out a questionnaire. This study was approved by the Medical Ethics Committee of the Universidad del Rosario in Colombia. Specific results on other analyses of this study have been presented in previous publications [10,11] or are under-review [12].

Data collection procedures

Questionnaire

In this study, we designed a questionnaire based on previous publications [1,9,13]. This questionnaire was administered to determine the occurrence of voice disorders, their associated factors and their consequences for care use and productivity losses. We included questions on the presence of voice symptoms in the past month and their characteristics; working conditions, such as noise and acoustic conditions; and costs of voice symptoms, namely health care use, voice-related absence and reduction in productivity at work.

Voice symptoms

For the purpose of this study, we defined the presence of voice symptoms by the single question “Have you had voice symptoms in the past month?”. We also included a list of 11 symptoms whereby teachers could indicate how many and what kind of symptoms they had had in the past month. Questions on severity and duration of symptoms were also included in the characterization of voice symptoms.

Direct and indirect costs of voice symptoms

The medical costs and productivity costs distinguished between direct costs for health care use and indirect costs for productivity losses due to a reduced performance at work and voice-related sickness absence. We defined costs of voice symptoms using six questions on whether participants had sought medical care due to their voice symptoms during the past month, and which health professional they had consulted [10]. The medical costs were delimitated to the total cost of an appointment with one or more health care provider. Teachers were also able to indicate whether they were absent from work during the past month because of voice disorders and for how long. Concerning productivity losses at work, participants indicated how much their voice disorders interfered with their productivity at work. A 0-10-point scale was used to determine the productivity loss at work, where 0=”no interference” and 10=”complete interference”?” [15]. In addition, they also indicated how long they experienced interference of voice disorders with their productivity at work in the past month. Because the frequency of answers for some categories was low, in further analyses “occurrence of productivity loss at work” were used as dichotomous variable, with subjects who answered any interference of the voice disorder with productivity at work (score 1 or higher) considered as being exposed.

Calculations to determine direct and indirect costs due to voice symptoms were based on legal rates in Colombia (see Table 1 for approximate rates in US dollars). To calculate direct costs (health care use), we added up to the cost per consultation for each health professional per teacher with voice symptoms in the past month. To calculate voice-related absenteeism costs, we multiplied the number of workdays missed due to voice symptoms per teacher by the wage per day. Calculations to determine productivity loss were done by multiplying the number of days worked with less productivity with the fraction of productivity loss due to voice symptoms per teacher by the wage per day.

Health-related conditions

Previous studies have reported associations between specific health conditions and occurrence of voice disorders [9,15,16]. Therefore, participants were also asked to fill in a short survey on the presence of respiratory diseases, gastrointestinal diseases, and hearing impairment [10].

Statistical analysis

Epi-info 3.5.3 software developed by Centers for Disease Control and Prevention (CDC) in Atlanta (USA) [18] was used for data entry, and SPSS 20 software, one of the brands under IBM software Group´s Business Analytics Portfolio, in New York (USA) [19] was used for statistical analysis. Because some variables had up to 3% missing values, multiple imputation was performed with the Fully Conditional Specification Method. This method imputes data on a variable-by-variable basis by specifying an imputation model per variable, allowing flexibility in creating multivariate models [20]. Descriptive statistics were used for characteristics of the study population. We used multiple logistic regression analysis to investigate associations between direct costs (health care use) and indirect costs (voice-related absenteeism and productivity loss at work) with characteristics of voice symptoms, socio-demographic characteristics, health conditions, and work-related factors. First, associations between direct costs and indirect costs as dependent variables with the independent variables were studied by univariate analyses. For the independent variables, those with a p-value lower than 0.20 in the univariate analysis were included in the multivariate analyses in order to avoid residual confounding [21], and were only retained if the p-value reached the conventional level of significance of 0.05. Second, multivariate analyses were performed applying stepwise selection with forward elimination of independent variables. These multivariate models included by default sex and age. The magnitude of the associations was expressed as the odds ratio (OR), and the statistical significance as the 95% confidence interval (95% CI).

RESULTS

Participant characteristics

In total, 621 out of 1,446 teachers agreed to participate in this research, representing a participation of 43%. Among the 621 participating teachers, 438 teachers reported voice complaints and therefore made up the study population.

As shown in Table 2, around 65% of the teachers were younger than 50 years old and 76% were female. No differences were observed in age between female and male teachers (mean age 45 years, range 23 to 64 years). Around 70% of teachers reported high noise levels and poor acoustics in their workplaces. More than 50% reported gastrointestinal diseases.

Voice symptoms

Table 2 shows that a high proportion of teachers reported two or more sensorial symptoms (58%) and auditory symptoms (52%). Around 50% of teachers reported a moderate severity of voice symptoms. Most of the teachers (72%) reported that voice symptoms lasted 5 days or less.

Direct and indirect costs of voice symptoms

As shown in Figure 1, most of the teachers with voice symptoms reported productivity loss at work due to voice symptoms in the past month (73%), which represents on average US$292 per teacher with voice symptoms. The second most reported economic consequence of voice symptoms was using health care services, 25% of teachers with voice symptoms reported having used the health care services for their voice symptoms in the past month, which represents on average US$16 per teacher with voice symptoms. Around 7% of teachers (n=29) reported sickness absence days with average duration of 3 days, which represents on average US$150. On average, total costs of voice symptoms per month were $US 458, with 64% of the costs being for productivity loss at work, 33% for voice-related absenteeism, and 3% for health care use. We found no relations between total medical costs and severity and duration of voice symptoms (Figures 2 and 3). However, as shown in Figures 4 and 5, it seems that more severe and prolonged voice symptoms increase total indirect costs.

Associated factors of direct and indirect costs of voice symptoms

As shown in Table 3, severity of voice symptoms was an important associated factor to prompt health care use and sickness absence. Teachers who reported severe voice symptoms more often sought health care use (OR=8.13) and more often had sickness absence (OR=7.99) than teachers with mild voice symptoms. Health care use was also associated with being female teacher (OR=2.06) and self-reported gastrointestinal diseases (OR=2.32). By contrast, the occurrence of productivity loss at work due to voice symptoms was not associated with severity of symptoms, but with poor acoustics in the workplace (OR=1.96) and self-reported hearing impairment (OR=2.12).

DISCUSSION

In this study, we investigated the medical costs and productivity costs of voice symptoms among teachers, in terms of health care use, voice-related absence, and productivity loss at work. In addition, we assessed the contribution of the characteristics of voice symptoms, socio-demographic characteristics, health conditions and work-related factors to the direct and indirect costs of these disorders among teachers. Our findings indicate that approximately 3% of the costs associated with voice symptoms

were direct costs for health care use and 97% were indirect costs for voice-related absenteeism and productivity loss at work. The indirect costs of voice symptoms were around 36% of the average teacher's monthly wage. Severity of voice symptoms was significantly associated with health care use and absenteeism.

We found higher prevalence of health care use compared with previous studies. In our study population around 25% of teachers with self-reported voice symptoms sought advice from health care in the past month. This finding is higher than Roy et al (2004) who reported a prevalence of health care use in the past year due to voice complaints of 12%. A Brazilian study reported health care use with 6% of teachers with possible and probable dysphonia seeking health care advice in the past 15 days [5]. Although previous studies have reported important barriers in access to health care services in Colombia [21-23], our results indicate that Colombian teachers reported seeking medical help for their voice problems more often than American teachers or Brazilian teachers.With regard to voice-related absenteeism, our findings indicated that around 7% of teachers reported absenteeism due to voice complaints in the last month. This is slightly higher than the study of De Medeiros et al (2008) who reported that 3% of teachers with possible and probable dysphonia had been absent from work in the past 15 days.

Our results indicated that the total medical costs and productivity costs of voice symptoms among teachers are comparable to around 37% of the average teacher's wage per month, with 3% of the costs being direct costs (health care use) and 97% indirect costs (voice-related absenteeism and productivity loss at work). The low proportion of direct cost could be partly related to potential barriers in access to health care in Colombia [22-24]. It is likely that teachers seek medical care when their voice symptoms are really severe and that teachers with less severe symptoms will limit themselves to over the counter medication. The latter was not measured in this study. The importance of severity of complaints for consultation with a general physician is also reflected in the high referral of 45% to an Ear, Nose and Throat Specialist (ENT) and 21% to a speech therapist (data not shown). In a study among teachers in Belgium a much lower referral of around 9% from general physicians to ENT specialists was reported [7], which may be due both to a quicker consultation of the general practitioner or a more stringent referral policy in the Belgian health care system.

Severity of voice symptoms was highly associated with voice-related absenteeism, generating indirect cost due to payment for sick leave [25]. On average, indirect costs of a teacher with voice symptoms per month were 910,200 Colombian pesos (around US$492). This productivity loss due to voice symptoms equals approximately 36% of the average teacher's monthly wage. This illustrates the substantial economic burden of voice symptoms and, thus, supports the importance of implementing programs of voice health promotion at work [26,27]. In this regard, Bovo et al (2007) reported improvements on voice symptoms as well as voice quality among teachers with voice disorders who participated in a program of voice training and vocal hygiene. Roy et al (2003) reported that teachers with voice symptoms who used electronic voice amplification improved in overall voice quality and vocal clarity.

Although few studies have reported determinants of health care use due to voice symptoms and voice-related absenteeism, contradictory results have been found. Our findings indicate that severity of complaints was an important factor of health care use and voice related absenteeism. Moreover, being female and gastrointestinal diseases were also associated with health care use. These findings are in concordance with the results of Da Costa et al (2012) who found that female teachers were more likely to seek health care use than men. In another Dutch study, voice-related absenteeism was associated with work-related factors such as moderate or bad acoustics, dry or moist humidity, and changing temperature [9]. In our study, we did not observe these associations for sickness absence, but for productivity loss at work. One reason for this discordance could be the differences in the composition of the study population, because Kooijman and colleagues (2006) included teachers with and without voice disorders and our study was limited to teachers with voice symptoms.

We would like to highlight our findings on productivity loss at work, because no previous studies assessed productivity loss at work due to voice symptoms among teachers. The self-perceived reduction of productivity at work due to voice symptoms represented 64% of the total costs of voice symptoms. Hence, most productivity losses were incurred among teachers who are at work but not fully productive due to voice symptoms. The association with hearing impairments suggests that for part of these productivity losses hearing problems may be the underlying cause, because hearing problems may prompt teachers to use a loud voice more often and aggravate existing voice problems. The presence of productivity loss was not associated with severity of voice complaints, which was partly due to the observation that teachers reported only modest productivity losses at work.

A limitation of this study was the cross-sectional nature that prevents insights into causality of the reported associations. Hence, we do not know in which time-window developing voice problems will result in health care use, absenteeism and productivity loss at work. In addition, the data on costs were collected for one month during the first months of the new school year. Costs may differ from later periods in the year, but we lack insight into time-dependent patterns of medical care. A second limitation is the reliance on self-reported economic consequences of voice complaints, partly due to lack of instruments to measure productivity loss objectively. A third limitation is that the medical costs may be underestimated in this study, because additional examinations and treatments following consultation of the general practitioner or medical specialist were not taken into account [28]. A fourth limitation is that the productivity costs were derived from information on average salary of teachers from national statistics rather than on individual wages actually paid by schools.

In conclusion, voice symptoms among teachers have important economic consequences due to health care use, voice-related absenteeism, and productivity loss at work. The total medical and productivity costs amounted to 37% of the average teacher's monthly wage. The results of this study suggest that severity of voice symptoms is an important factor for health care use and absenteeism, but less important for self-perceived productivity loss at work. To the best of our knowledge, this is the first

study to analyse the relation between voice symptoms´ characteristics and productivity losses, it is recommended to develop more research on the association between severity of voice symptoms and its impact on self-perceived productivity loss at work.

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Table 1. Prices used in the productivity and medical cost analysis

Item	Costs
Teacher wage*	
Average salary per month of teachers without specialization	US$1,014
Average salary per month of teachers with specialization	US$1,117
Average salary per month of teachers with master degree	US$1,603
Average salary per month per teacher	US$1,245
Net salary costs of a teachers' hour in Colombia	US$12
Medical Costs **	
General practitioner consultation	US$12
Ear, Nose and Throat specialist	US$18
Speech therapist	US$8

* According with Decree 0826/2012

** According with Decree 2423/2006 up-to-date (2012)

Table 2. Characteristics of participating teachers with voice symptoms in 12 public schools in Bogotá D.C., Colombia

	Teachers (n=438)	
Variable	**N**	**%**
Socio-demographics		
Female gender	332	76
50 or more years old	153	35
Self-reported work-related factors		
High Noise in workplace	309	71
Poor acoustics in workplace	298	68
Dry air in workplace	219	50
Changes in temperature in workplace	255	58
Dust in workplace	268	61
Health factors		
Respiratory diseases	184	42
Gastrointestinal diseases	236	54
Hearing Impairment	156	36
Sensorial symptoms*		
0 symptoms	52	12
1 symptoms	133	30
2-5 symptoms	253	58
Auditory symptoms+		
0 symptoms	57	13
1 symptoms	153	35
2-6 symptoms	228	52
Severity of voice symptoms		
Mild	162	37
Moderate	220	50
Severe	56	13
Duration of voice symptoms		
2 days or less	146	33
3 - 5 days	171	39
6 days or more	121	28

* Symptoms included= Tired voice, vocal fatigue, dry throat, itchy sensation, pain in throat

+Symptoms included= Hoarseness, weak voice, voice spasms, voice loss, strained voice, breathiness

Table 3. Multivariate analyses of associations between economic consequences of voice symptoms with socio-demographic characteristics, voice symptoms' characteristics, self-reported work-related factors and self-reported health conditions in 12 public schools in Bogotá D.C., Colombia

	Health care use		Voice-related absenteeism		Productivity loss at work	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Socio-demographics						
Female gender	2.06	(1.04 - 4.09)	0.76	(0.31 - 1.86)	0.99	(0.59 - 1.66)
50 or more years old	1.52	(0.89 - 2.58)	2.36	(1.05 - 5.29)	0.80	(0.49 - 1.32)
Characteristics of voice symptoms						
Severity of voice symptoms						
Mild	1.00	Referent	1.00	Referent		
Moderate	3.34	(1.71 – 6.52)	1.28	(0.45 - 3.62)		
Severe	8.13	(3.57 – 18.49)	7.99	(2.81 - 22.72)		
Duration of voice symptoms						
2 days or less	1.00	Referent				
3 - 5 days	2.15	(1.07 – 4.33)				
6 days or more	2.82	(1.35 – 5.89)				
Self-reported work-related factors						
Poor acoustics in workplace					1.96	(1.22 - 3.13)
Self-reported health conditions						
Gastrointestinal diseases	2.32	(1.36 - 3.97)				
Hearing Impairment					2.12	(1.26 - 3.56)

Figure 1. Prevalence and associated costs (mean and interquartile range) of health care use, voice-related absenteeism and productivity loss at work among teachers with voice symptoms in 12 public schools in Bogotá D.C., Colombia

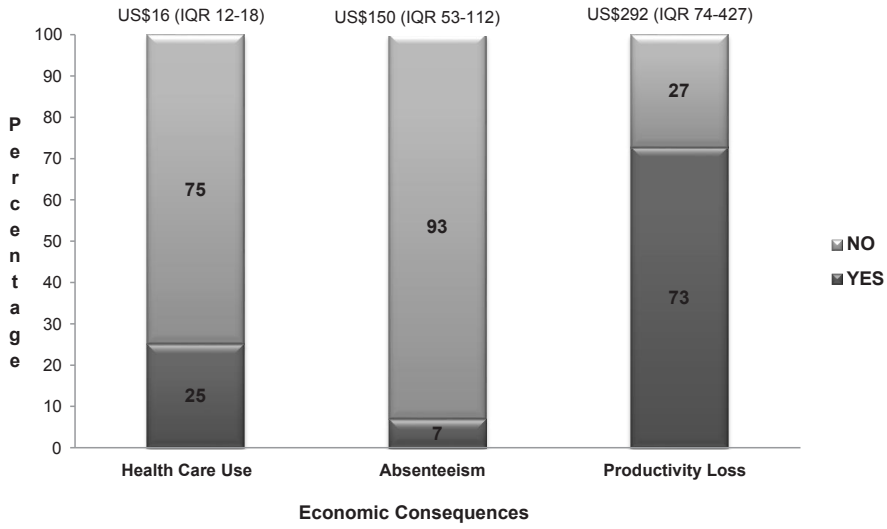


Figure 2. Relation between direct costs in $US (mean) and severity of voice symptoms (VS) in 12 public schools in Bogotá D.C., Colombia

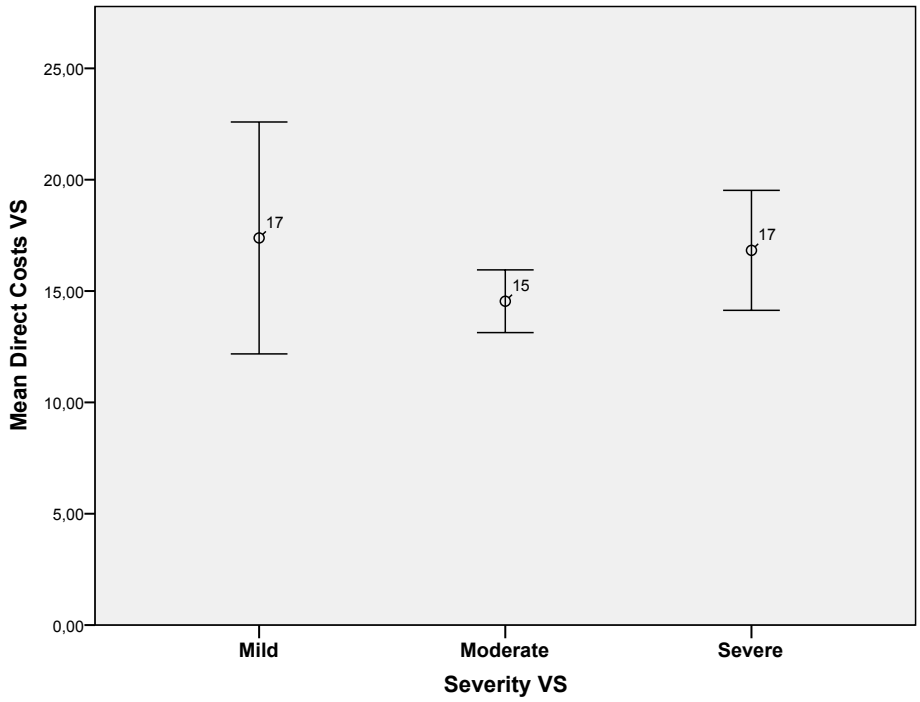
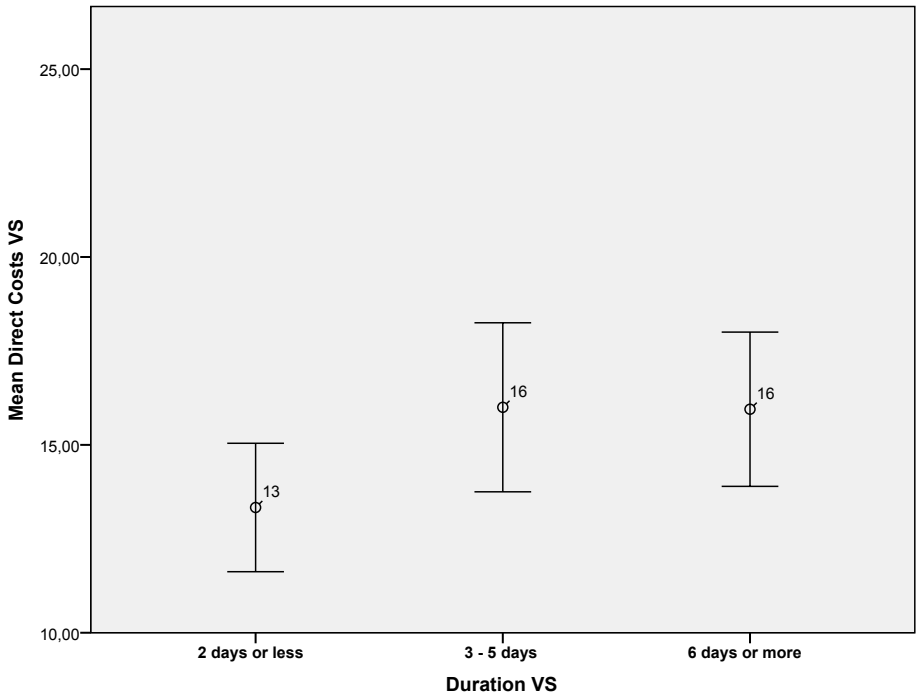


Figure 3. Relation between direct costs in $US (mean) and duration of voice symptoms (VS) in 12 public schools in Bogotá D.C., Colombia



Error Bars: 95% CI

Figure 4. Relation between indirect costs in $US (mean) and severity of voice symptoms (VS) in 12 public schools in Bogotá D.C., Colombia

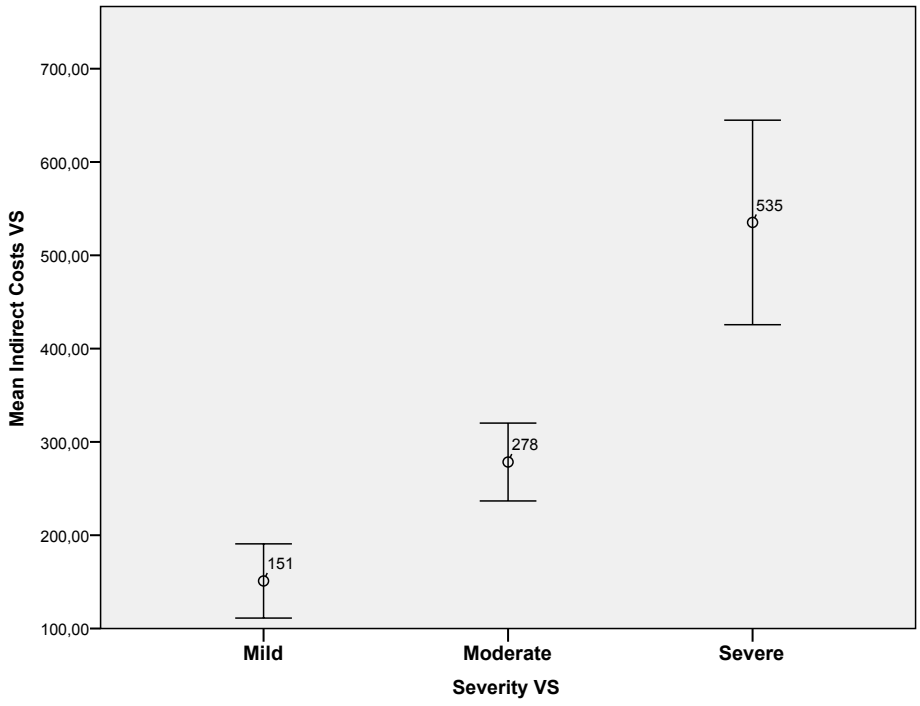
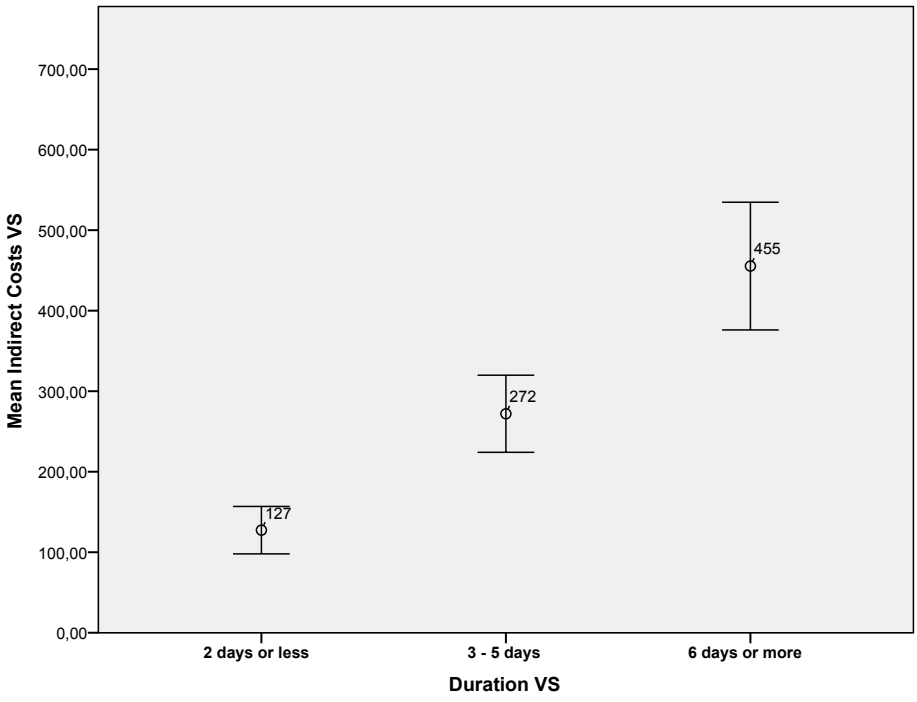


Figure 5. Relation between indirect costs in $US (mean) and duration of voice symptoms (VS) in 12 public schools in Bogotá D.C., Colombia



Error Bars: 95% CI

Chapter 8

DISCUSSION

In this final chapter, the main findings in the light of the objectives of this thesis will be presented, methodological issues will be discussed, new insights will be considered, and recommendations for practice and future research will be given.

MAIN FINDINGS

Objective 1: To assess the presence of voice disorders among teachers

Three chapters of this thesis explore the occurrence of voice disorders among teachers. **Chapter 2**, a systematic review, showed that although teachers had a significantly increased occurrence of voice disorders compared to other occupations, a large variation in occurrence of voice disorders was observed. We identified three sources of this large variation. First, a publication that asked for a wide range of voice symptoms reported a 12-month prevalence of 80% [1] while a publication that used a specific definition of voice disorder reported a 12-month prevalence of 15% [2]. Second, publications with unspecified recall period resulted in prevalences up to 94% [3] while the point prevalence of voice disorders was 9% [4]. Third, publications that used questionnaires reported prevalences up to 69% [5] while publications that included objective measures in their assessment methods resulted in prevalences up to 57% [6].

Following the results of the literature review, in **Chapter 4**, a cross-sectional study was conducted in 12 public schools in Bogotá to gained more insight into the actual occurrence of voice disorders among teachers. The occurrence of self-reported voice complaints during the past month among teachers was 71%. In addition, teachers reported voice symptoms more often than non-teachers did (OR=2.03, 95%CI 1.19-3.46).

Chapter 5 of this thesis, the longitudinal study, gained more insight into the changes in occurrence of voice disorders during an eleven-months-follow-up. This study shows that the prevalence of voice complaints among teachers did not change significantly (68%). Moreover, the recurrence of voice complaints among teachers was 78%. However, the episodic nature of voice complaints was also demonstrated by a recovery of 22% and an annual incidence of 44%.

Objective 2: To evaluate the agreement between different methods of assessment of voice disorders among teachers

Chapter 3 of this thesis explored the agreement between self-report of voice complaints, perceptual assessment of voice disorders, and objective parameters of voice quality. The results showed that perceptual assessment showed no agreement with

self-reported voice complaints (κ=0.12) and had little agreement with maximum phonation time (AUC=0.59). Maximum phonation time also showed little agreement with self-report of voice complaints (AUC=0.56). The multivariate analysis showed that after mutual adjustment for relevant factors in the univariate analyses, age and maximum phonation time remained associated with perceptually diagnosed voice disorders.

Objective 3: To identify work-related determinants of voice disorders among teachers

Three chapters of this thesis explore the work-related determinants of voice disorders among teachers. In **Chapter 2**, the systematic review, we found that being a teacher is statistically associated with voice disorders with odds ratios (ORs) ranging from 1.89 [3] to 4.61 [5]. High noise level in the classrooms was associated with voice disorders among teachers in three publications with ORs ranging from 1.51 [6] to 5.18 [2]. Teachers who reported bad acoustic conditions in the classrooms also reported twice as often voice disorders than teachers who reported good acoustic conditions. Physical education instructors were found more likely to report voice disorders compared with teachers who teach other subjects with ORs ranging from 1.46 [7] to 3.70 [8].

Chapter 4, the cross-sectional study, showed that high noise levels outside schools (OR= 1.83; 95% CI 1.12-2.99) and self-reported poor acoustics at the workplace (OR = 2.44; 95% CI 1.88-3.53) were associated with voice complaints. In line with these results, **Chapter 5**, the longitudinal study, showed that self-reported high noise level at the workplace was associated with the incidence of voice complaints, and self-reported poor acoustics in the classroom was associated with recurrence of voice complaints. Objectively measured physical conditions at the workplace were not associated with neither incidence not recurrence of voice complaints. Objective measurements of high noise outside the school and high humidity at the workplace were associated with a reduced likelihood of recurrent voice complaints, but after adjustment, these associations were no longer statistically significant.

Objective 4: To identify the socio-economic consequences of voice disorders among teachers

Chapter 6 of this thesis presents the results on the associated factors of the scores on the Voice-Related Quality of Life (V-RQOL) and Voice Activity and Participation Profile (VAPP) instruments. The results showed that individual factors, work-related factors, and the economic consequences of voice complaints were similar for the two instruments. The findings suggest that the V-RQOL and VAPP share associated factors, showing that their approaches to quality-of-life assessment are similar.

Chapter 7 of this thesis, a cross-sectional study, showed that among teachers with voice disorders around 3% of the costs were direct costs for health care use and 97%

were indirect costs for productivity losses. Around 25% of teachers (n=108) reported use of health care services for their voice symptoms in the past month. Around 7% of teachers (n=29) reported sickness absence days with average duration of 3 days, and 73% of teachers (n=304) reported productivity loss at work due to voice symptoms in the past month. On average, total costs of voice symptoms per month were $US 458, with 64% of the costs being for productivity loss at work, 33% for voice-related absenteeism, and 3% for health care use. We found no relations between total medical costs and severity and duration of voice symptoms. However, it seems that more severe and prolonged voice symptoms increased total indirect costs.

METHODOLOGICAL ISSUES

For the interpretation of the findings of this thesis, some methodological issues must be taken into account. As some of these have already been discussed in previous chapters, in this section we will review more general methodological issues concerning study population, study design, and measurement methods of the cross-sectional and longitudinal studies.

Study population

Chapters 3 to 7 were based upon a study with voluntary participation of schools, teachers and non-teachers, which may have suffered from non-response bias. Information of non-responders was not available other than that participating and non-participating schools did not differ by localization in Bogotá, where the Department of Education manages public schools. Work-related aspects as number of students per class, numbers of working hours per week, physical conditions of the classrooms, among others, are not coordinated by the schools themselves but by the Department of Education. Therefore, we suggest that the results of this research resemble the situation in public schools in Bogotá.

Another source of bias might be the non-response of teachers and non-teachers within the schools, since it was on voluntary basis. In the 12 participating institutions, schools with higher participation were those whereby head teachers designated specific moments to inform and invite teachers and non-teachers to participate (for instance in pedagogical meetings). Schools where data collection was made during breaks between classes or at the end of the classes had lower participation. Nevertheless, the non-response has not biased the prevalence of the voice complaints because there was no association between high response and prevalence of voice complaints among the participating schools.

A third potential limitation concerns the fact that a selective loss to follow-up could have influenced our results. The relationship between voice disorders and work-related factors (for instance, teaching) might be distorted if non-teachers without voice disorders were lost to follow-up. Therefore, the association between voice disorders and teaching may have been underestimated.

On the other hand, this study has a relatively large number of participating teachers. Larger samples contain more information about characteristics which are of interest, and hence facilitate more precise estimation of the true situation in the study population [9]. On the other hand, a potential limitation concerns the small number of participating non-teachers, which hampers the power of the reported associations.

Study design

Chapters 3 to 7 were based upon a cohort design that consisted of two measurements during an eleven-months-follow-up. To our knowledge, this study is the first cohort study on voice disorders among teachers. This design allows to record change on the occurrence of voice disorders during the follow-up. However, the follow-up in this study was not long enough to identify a trend in the occurrence of voice disorders among teachers over time. Longitudinal studies with longer follow-up with repeated measurements are needed to draw firmer conclusions on the changes in occurrence of voice disorders among teachers, their work-related factors and their consequences.

On the other hand, in this research the non-exposed group was not an external comparison group (for instance, general population or workers from others fields) but a group of non-teachers who worked in the same schools that teachers did. The selection of this "internal" comparison group offers certain advantages, such as better comparability of working conditions and psychosocial climate, but also disadvantages, such as similar physical environment.

Measurement methods

In this thesis, we collected individual and environmental information. The information was collected by three methods: self-reports by participants, subjective assessment by the principal researcher, and objective assessment by voice objective analysis, and acoustic and climate measurements.

Voice assessment

Chapters 3 to 7 of this thesis showed results on self-reported voice complaints. Self-reports of voice status have been used widely to assess voice disorders because is easy, cheap and quick. However, reporting and recall bias could occur when self-reports are used. Responders with chronic voice disorders are thought to be able to recall more accurately their symptoms than teachers with acute or occasional voice disorders. Nevertheless, due the short recall period used in this study, it is not likely that recall bias has influenced our findings.

In **Chapter 3** results on voice disorders by self-reports, subjective assessments, and objective assessments were compared. Perceptual assessment is a quick, unobtrusive and comfortable method to assess voice disorders. Since voice is fundamentally a perceptual phenomenon, perceptual nature of voice is highly likely to be reflected in the perceptual features of voice assessment. We used the GRBAS scale to perform the perceptual assessment because it has been demonstrated to be efficient in various studies [10,11]. In addition, GRBAS scale implementation is quick and easy. Nevertheless, subjectivity of perceptual assessment has been criticized. There is a lack of consensus on the reliability of this assessment, especially when voices are mildly– moderately impaired. Moreover, perceptual analysis requires highly trained listeners in order to be performed adequately [11,12]. In this study, a speech therapist with experience in clinical voice assessment as well as in studies using perceptual voice analysis performed the perceptual assessments. The intra-listener agreement was evaluated by assessing a sample of voice recordings (n=30) in two different randomized order on each of two separated days by 5 weeks. Our results indicated good intra-listener agreement (κ=0.71). In addition, we assessed the reliability of ratings of the single listener by including a second listener to judge a sample of voice recordings (n=30). Nevertheless, we found fair agreement between listeners (κ=0.33).

On the other hand, objective voice analysis is an effective and non-invasive tool for voice assessment. In this study, we used *Praat* software because it is a freely available personal computer-based analysis software. One advantage of voice objective assessment is that estimation of the acoustic parameters is independent of the assessment of the listener. Nevertheless, some factors could interfere with the accuracy in the calculations of the acoustic parameters, such as background noise level during recording the voice sample, quality of the voice recorder, and the distance between the microphone and the mouth. In this study, the voice samples were recorded in an empty and quiet classroom or in the teachers' lounge to avoid the background noise as much as possible. In addition, the digital recorder was placed at a distance of 5-6 cms from the mouth. This short distance was selected to minimize the effects of the room acoustics [13]. Another disadvantage is that acoustic analysis is time-consuming and requires considerable voice laboratory expertise [12]. In this study, a speech therapist with experience in clinical voice assessment performed the acoustic voice analyses.

Working conditions

In **Chapter 4** and **Chapter 5** of this thesis, we presented results on self-reported physical working conditions, such as background noise, acoustic conditions, dust and temperature. Assessment of work-related factors of voice disorders by self-reports has been used widely because is easy, cheap and quick. One disadvantage of self-reports is that reporting and recall bias could occur because participants may tend to answer towards perceived socially desirable standards. Thus, unfavourable physical working conditions might be overestimated. In addition, responders with voice disorders are thought to be able to recall more accurately many work-related and individual factors, compared with responders without voice disorders, because the outcome serves as a stimulus for the teachers and non-teachers to consider potential causes [14].

Expert assessment of physical working conditions has the advantage of being cheap and practical for use in a wide range of workplaces. In this study, we used the "Indoor Air Quality and Hygiene and Safety Checklist". This checklist was based on existing questionnaires described in the literature and designed in such a way that ventilation conditions, humidity conditions, hygiene conditions, and safety conditions were included. Subjectivity of the assessment of physical working conditions by a walk-through survey is an important issue. Intra and inter-observer variability when choosing the exposure level could be significant [15]. Nevertheless, all workplace-based assessments were performed by a professional with previous experience, but no effort was made to investigate how well the expert assessment matched objective measurements.

Results on objective assessment of physical working conditions are presented in **Chapter 4** and **Chapter 5**. The objective assessment offers information comparable with international standards required to determine the technical interventions needed to improve the physical environment. Nevertheless, this assessment requires trained experts in order to be performed adequately [16-18]. In this study, measurements were performed by an experienced professional, but due to time limitations, the number of measurements over the exposure history of the participants in the cohort study was limited. This may have resulted in some misclassification of exposure at individual level.

NEW INSIGHTS

- ***A stable pattern of occurrence of voice disorders among teachers***

Previous research has suggested that voice disorders are highly prevalent among teachers. However, the variation of voice disorders over time has not been explored. This thesis showed no significant change in the prevalence of voice disorders among teachers over an eleven-months-follow-up period. In addition, a rather modest incidence and recovery of voice disorders among teachers was found, relative to the high

proportion of teachers who reported recurrent voice disorders during the follow-up.

- ***Poor acoustic conditions as a determinant of voice disorders among teachers***

Work-related and individual factors of voice disorders among teachers have been reported previously. However, the evidence presented is primarily based on cross-sectional designs. This thesis showed that poor acoustics in the workplace was associated with self-reported voice disorders over time, but it remained difficult to demonstrate the specific influence of separate physical conditions on voice disorders.

- ***Self-reports of voice disorders as an efficient assessment tool of voice disorders among teachers***

Previous research on voice disorders among teachers have been based mainly on self-reports. However, the relationship among self-reports, perceptual assessment of voice quality (considered as a good approach for voice assessment) and objective assessment is unclear. This thesis showed that estimates of occurrence of voice disorders varied widely among the three assessment methods. Nevertheless, the best expert on his/her own voice is the person who use it on daily basis. Therefore, self-reports seem to be a good approach to assess voice disorders among teachers.

- ***Economic burden of voice disorders among teachers***

Consequences of voice disorders have been moderately explored. Previous studies have shown that voice disorders impact negatively on quality of life of teachers, and that teachers with voice disorders are more likely to be absent from work. Nevertheless, costs associated with voice disorders among teachers are undetermined. **Chapter 7** of this thesis showed that direct costs (health care use) were low compared with indirect costs (absence from work and productivity loss) due to voice disorders (3% and 97%, respectively). These indirect costs would be around 36% of the average teacher's wage, illustrating the economic burden of voice disorders.

RECOMMENDATIONS FOR PRACTICE

- ***Designing classrooms with adequate acoustic characteristics***

The results of **Chapter 4** and **Chapter 5** of this thesis showed that self-reported poor acoustics at workplace are associated with self-reported voice disorders. It is recommended to include acoustic solutions in the designs of new schools, in order to provide workplaces with optimal conditions for voice use and teaching-learning process during teaching activities.

- ***Self-reports and voice disorders among teachers***

The results of **Chapter 3** of this thesis indicated that self-reports of voice complaints, perceptual assessment of voice quality and objective assessment of voice parameters offer complementary information on voice functioning. Self-reports are a recommendable tool to assess voice complaints among teachers because it is quick, easy and reliable, when using a short recall period and clearly defined symptoms.

RECOMMENDATIONS FOR FUTURE RESEARCH

- ***Longitudinal studies with longer follow-up and repeated measurements***

To our knowledge, this research is the first longitudinal study on voice disorders among teachers. A stable pattern of occurrence of voice disorders among teachers was found during the follow-up. However, the follow-up was short and included just two repeated measurements. Longitudinal studies with longer follow-up and repeated measurements are needed to describe more accurately the changes in occurrence of voice disorders among teachers.

- ***Economic evaluation studies on voice disorders among teachers***

This is one of the first studies on socio-economic consequences of voice disorders among teachers. The results of this thesis showed that 3% of the costs were related with medical consumption. Severity and duration of voice symptoms prompted medical care seeking. Nevertheless, information on frequency of consultation and other examinations and treatments needed were not explored in this research. The influ-

ence of barriers and facilitators in the access to health care should also be assessed, in order to gain more insight in the direct health care costs of voice disorders among teachers.

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SUMMARY

Voice disorders are a major problem among teachers. However, the reported prevalence of these disorders have a wide range, and the natural variation of voice disorders among teachers is unknown due to the lack of longitudinal studies. Moreover, there is not a consensus about the best approach for assessing voice disorders among teachers at work. Results on prevalence of voice disorders in this occupational group are based on different sources (questionnaires, perceptual assessment, clinical assessment, acoustical assessment), which make difficult the comparison of these results.

On the other hand, associated factors of voice disorders among teachers include individual factors, such as sex and age; and work-related conditions, such as acoustic and noise conditions, topic of teaching and using loud voice. Yet, there is a lack of knowledge regarding the *determinants* of voice disorders among teachers. In addition, voice disorders have a big impact on quality of life and daily performance of teachers. Moreover, voice disorders may interfere with the productivity at work, and thus generate economic costs to the schools and the teachers due to the voice-related absenteeism, reduction in productivity at work, and use of health services.

This thesis focused on the occurrence, causes and consequences of voice disorders among teachers. **Chapter 1** describes the motivation of this thesis and its specific aims. The four study aims addressed in this thesis are:

1. To assess the presence of voice disorders among teachers
2. To evaluate the agreement between different methods of assessment of voice disorders among teachers
3. To distinguish work-related determinants of voice disorders among teachers
4. To identify the socio-economic consequences of voice disorders among teachers

We present in this thesis results on a systematic review (Chapter 2), one cross-sectional study (Chapter 3, 4, 6 and 7) and one longitudinal study (Chapter 5) that addressed the four aims.

Occurrence of voice disorders among teachers

Chapter 2 presents a systematic review examining the relation between work-related and individual factors and the occurrence of voice disorders among teachers. A total of 23 publications were included. All publications were cross-sectional studies. We found that prevalence estimates range from 9% to 94%, reflecting disparity in definitions of "voice problem", in recall periods used in the questionnaires, and in the assessment methods used to evaluate voice disorders. From this systematic review, we found that teachers had a significantly increased occurrence of voice disorders compared to other occupations. The findings were in line with the cross-sectional and longitudinal studies presented in chapters 4 and 5.

Methods of assessment of voice disorders among teachers

In **Chapter 3**, we assessed the agreement between self-perceived voice complaints, perceptual assessment, and objective voice analysis. The participants were 574 teachers in 12 public schools in Bogotá, who agreed to fill out a questionnaire and record a voice sample. We found no agreement between perceptual evaluation by means of GRBAS scale, self-reported voice complaints and objective analysis of the voice. From the results of this study, we concluded that these three assessment methods show large differences and may offer different information about voice quality and functioning. Therefore, it is recommended to include in the assessment of work-related voice disorders information concerning these three assessment methods.

Effects of working environment on voice performance of teachers

Chapter 4 describes results of the cross-sectional study including 682 Colombian school workers at 377 workplaces in 12 public schools in Bogotá. The study assessed the association between objectively measured and self-reported physical conditions at school with the presence of voice symptoms among teachers. The results indicated that high noise levels outside schools and self-reported poor acoustics at the workplace were associated with voice symptoms. We found a poor agreement between the objective measurements and self-reports of physical conditions at the workplace. From this study, we concluded that noise and acoustics might play a role in the occurrence of voice symptoms among teachers. In addition, objective measurements and self-reports of physical conditions may be different entities; therefore, it is advisable to include physical measurements of the working environment in studies that measure the impact of noise and acoustics on vocal health.

The results of the longitudinal study are presented in **Chapter 5**. The longitudinal study included 480 school workers. The results showed that, on the one hand, voice complaints are recurrent with a low recovery of 22%. Moreover, the annual incidence of voice complaints among these school workers was of 44%. On the other hand, the self-reported high noise level at the workplace was associated with the incidence of voice complaints; and the self-reported poor acoustics in the classroom was associated with recurrence of voice complaints. The results of this study are in line with the results of the cross-sectional study presented in chapter 4, and suggest that poor acoustics and high noise levels at the workplace may contribute to the recurrence and incidence of voice complaints among teachers.

Consequences of voice disorders among teachers

We assessed in **Chapter 6** the associations of the scores on the Voice-Related Quality of Life (V-RQOL) and Voice Activity and Participation Profile (VAPP) instruments with socio-demographic characteristics, voice complaint characteristics, work-related factors, health conditions and consequences of voice complaints. The participants of this cross-sectional study were 438 Colombian schoolteachers with voice complaints. The results showed that severity of voice complaints, auditory symptoms, hearing impairment, class size, and poor acoustics in the workplace were associated with the scores derived from the questionnaires of both V-RQOL and VAPP instruments. Moreover, the associations between the score and the economic consequences of voice complaints were also similar for the two instruments. From these results, we may conclude that the V-RQOL and VAPP instruments have similar approaches to the assessment of quality-of-life among teachers with voice complaints. **Chapter 7** presents the medical costs and productivity costs of voice symptoms among teachers, and the contribution of the characteristics of voice symptoms, socio-demographic characteristics, health conditions and work-related factors to these costs. The total medical costs and productivity costs due to presence of voice symptoms among teachers amounted to around 37% of their monthly wage (around 97% were indirect costs for productivity losses). Of special interest was the finding that severity of voice symptoms was significantly associated with health care use and voice-related absenteeism. From these results we may concluded that the increase on health care use, absenteeism, and productivity loss at work due to voice disorders among teachers represent an important burden of these disorders.

In **Chapter 8,** we integrated the results of the studies that compose this thesis. In this chapter, we presented the main conclusions, study limitations, and recommendations for practice and research. Concerning the first aim, the main conclusions were that (1) Occurrence of voice disorders among teachers is significantly higher compared with other occupations; (2) The prevalence of voice complaints among teachers did not change significantly during one school year; (3) Voice disorders are a chronic disease among teachers with a recurrence of 78%; but also and episodic disease with an annual incidence of 44%. The main conclusion regarding the second aim was

that self-reports of voice complaints, perceptual assessment by clinician and objective analysis of voice parameters, offer complementary information on voice disorders among teachers. About the third aim, the main conclusions were: (1) Being a teacher is an associated factor of voice complaints. (2) High noise levels outside schools and self-reported poor acoustics at the workplace are associated factors of self-reported voice complaints. (3) Self-reported high background noise levels and poor acoustic conditions at the workplace were associated with the incidence and recurrence of voice complaints, respectively. The main conclusions concerning the fourth aim were that (1) The V-RQOL and VAPP share associated factors, showing that their approaches to quality-of-life assessment are similar; (2) Around 3% of the costs associated with voice complaints were direct costs for health care use and 97% were indirect costs for productivity losses; (3) More severe and prolonged voice symptoms increased total indirect costs.

Rome was not built in a day and this thesis would have not been possible without the kind support and help of many individuals and organizations throughout. I am enormously grateful to all of you!

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VOORD (Acknowledgment)

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ABOUT THE AUTHOR

Lady Catherine Cantor Cutiva was born in Bogotá D.C, Colombia, on 22nd of August of 1984. She grew up in Bogotá. In 2000, she finished her secondary education. From 2001 until 2005, Lady studied Speech and Language Therapy and Audiology at Universidad Nacional de Colombia in Bogotá. Until 2007, Lady worked as a practicing Logopedist treating individuals and groups with communication disorders. In 2009, she graduated in Work and Safety at work at Universidad Nacional de Colombia. The Master thesis described the occurrence and work-related factors of voice disorders among college teachers. She started her trajectory as Philosophical Doctor candidate from August 2010 at the Department of Public Health of the Erasmus Medical Center. The studies are described in this thesis. During this time, she obtained her second Master, the Master of Health Sciences with Specialisation Public Health, at the Netherlands Institute of Health Sciences (Nihes). She additionally starts to work as research fellow at the Politecnico di Torino, Italy, at the Department of Energy (DENERG), where she is still working.

LIST OF PUBLICATIONS

Publications in this thesis

Cantor Cutiva, Lady Catherine; Vogel, Ineke; Burdorf, Alex. **Voice disorders in teachers and their associations with work-related factors: a systematic review**. Journal of Communication Disorders. 2013, 46(2): 143-55

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Factors associated with voice-related quality of life among teachers with voice complaints.** Journal of Communication Disorders. 2014, 52: 134-42

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Effects of noise and acoustics in schools on vocal health in teachers**. Noise & Health. 2015, 17(74): 17-22

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Medical costs and productivity costs related to voice symptoms in Colombian teachers.** Journal of Voice*, Accepted*

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Determinants of voice complaints among school workers: An eleven-months-follow-up study**. *Submitted*

Cantor Cutiva, Lady Catherine; Fajardo, Adriana; Burdorf, Alex. **Are there any associations between self-perceived voice complaints in teachers, perceptual voice assessment by a speech therapist, and acoustic voice analysis?** *Submitted*

Other publications

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Los problemas de voz en los docentes... ¿Qué los genera? y ¿cuánto cuestan?** Revista de Salud Pública del Instituto de Salud Pública de la Facultad de Medicina de la Universidad Nacional de Colombia. *Submitted*

Cantor Cutiva, Lady Catherine; Burdorf, Alex. **Objective voice parameters in Colombian school workers with healthy voices**. Revista Ciencias de la Salud. *Submitted*

PHD PORTFOLIO

Summary of PhD training and teaching

Name: Lady Catherine Cantor Cutiva
PhD period: 2010 – 2014

Erasmus MC Department of Public Health
Promotor: Lex Burdorf

Research school: Nihes

	Year	Workload (Hours/ECTS)
1. PhD training: 51.75 ects		
General courses: 4.2 ects		
- Summer course English	2010	1.4 ects
- Introduction to medical writing	2011	1.1 ects
- Biomedical english writing and communication	2013	1.7 ects
Statistics: 12.95 ects		
- Classical methods for data-analysis	2010	5.7 ects
- Modern statistical methods	2010	4.3 ects
- The practice of epidemiologic analysis	2010	0.7 ects
- Courses for the quantitative researcher	2011	1.4 ects
- Working with SPSS for Windows	2010	0.15 ects
- Topics in meta-analysis	2011	0.7 ects
Methodology: 11.4 ects		
- Public health research methods	2010	5.7 ects
- Study design	2010	4.3 ects
- Methods of health services research	2010	0.7 ects
- Methods of public health research	2010	0.7 ects
Specific courses: 11 ects		
- International comparison of health care systems	2010	1.4 ects
- Site visit to Municipal Health Service Rotterdam	2010	0.3 ects
- Integration module	2011	0.3 ects
- Principles of research in medicine	2010	0.7 ects
- Clinical decision analysis	2011	0.7 ects
- Health economics	2011	0.7 ects

- Conceptual foundation of epidemiologic study design	2011	0.7 ects
- Introduction to public health	2010	0.7 ects
- Primary and secondary prevention research	2010	0.7 ects
- History of epidemiologic ideas	2011	0.7 ects
- Social epidemiology	2010	0.7 ects
- Planning and evaluation of screening	2011	1.4 ects
- Quality of life measurement	2011	0.9 ects
- From problem to solution in public health	2011	1.1 ects
Seminars and workshops: 3.6 ects		
- Attending seminars at the Department of Public Health (MGZ)	2011-2013	3.6 ects
- Oral presentation at the World voice day	2014	1 ects
- Presentation during conference “Colombia nos une”	2013	0.4 ects
- Poster presentation during conference of The Voice Foundation	2013	1 ects
- Oral presentation at the 10th pan-European voice conference	2013	1 ects
- Poster presentation during conference of AOHC	2012	1 ects
International conferences: 4.2 ects		
- The Voice Foundation’s 42nd Annual Symposium: Care of the professional voice	2013	1.4 ects
- 10th pan-European voice conference, Prague, Czech Republic	2013	1.4 ects
- 97th annual meeting of the American Occupational Health Conference	2012	1.4 ects
2. Research: 42.9 ects		
- Development research proposal	2010	2.5 ects
- Oral research presentation	2011	1.4 ects
- Research fellow period (Politecnico di Torino)	2014	39 ects
3. Supervision of bachelor thesis: 6 ects		
- Supervision of five bachelor students ‘speech and language therapy and audiologist’ of Universidad del Rosario. Thesis tittle: Voice disorders among teachers. Modality: Research assistant	2012	5 ects

- Co-supervision of bachelor student 'Logopedia' of Università di Torino. Thesis tittle: "La prevenzione dei disturbi vocali nei futuri professionisti della voce" (Prevention of voice disorders among future professional voice-users)	2014	1 ects
		Total 100.65 ects