

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

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### ABSTRACT

**Purpose:** 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.

**Method:** 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”, and “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.

**Results:** 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.

**Conclusion:** This review shows that teachers report voice disorders more often than non-teachers. 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.

#### Learning outcomes:

- Describe the occurrence of voice disorders among teachers
- Identify some work-related factors of voice disorders among teachers
- Interpret the quality of the publications to describe or analyze the relationship between working conditions and voice disorders among teachers

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## 1. Introduction

About one third of the labor force works in professions in which the voice is their primary tool (Vilkman, 2000). Excessive use or abuse of the voice at work can lead to voice disorders (Williams, 2003). 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” (ASHA, 1993).

Some studies suggest that workers, whose professions are vocally demanding, such as teachers, may be at greater risk for developing voice disorders (Alves, Do Carmo Cruz Robazzi, Marziale, De Felipe, & Da Conceicao Romano, 2009; Mattiske, Oates, & Greenwood, 1998; Williams, 2003). 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 (Mattiske et al., 1998; Williams, 2003).

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 (Ilomaki et al., 2009; Jonsdottir, Boyle, Martin, & Sigurdardottir, 2002; Mattiske et al., 1998; Pekkarinen, Himberg, & Pentti, 1992; Williams, 2003). Nevertheless, there is a clear lack of consensus about which working conditions are associated with the development of voice disorders in this occupation (Mattiske et al., 1998).

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 (Vilkman, 2004). 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 (Betancourt, 1999; Eurofond, 2011).

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 (ASHA, 2004).

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.

## 2. Method

### 2.1. Literature search

Comprehensive literature searches were conducted using three computerized databases: PubMed/MEDLINE (National Library of Medicine, Bethesda, MD) 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.

### 2.2. Study selection

Initially, titles and abstracts of all papers identified were screened. For final inclusion, publications had to fulfill 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.

Fig. 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, and Lofqvist (2010), Angelillo, Di Maio, Costa, Angelillo, and Barillari (2009), Chen, Chiang, Chung, Hsiao, and Hsiao (2010), Chong and Chan (2010), Costa, Prada, Roberts, and Cohen (2010), De Jong et al. (2006), De Medeiros, Barreto, and Assuncao (2008), Jonsdottir et al. (2002), Kooijman et al. (2006), Miller and Verdolini (1995), Pekkarinen et al. (1992), Preciado-Lopez, Perez-Fernandez, Calzada-Uriondo, and Preciado-Ruiz (2008), Roy, Merrill, Thibeault, Gray, and Smith (2004), Roy, Merrill, Thibeault, Parsa, et al. (2004), Sala, Laine, Simberg, Pentti, and Suonpaa (2001), Sliwinska-Kowalska et al. (2006), Smith, Gray, Dove, Kirchner, and Heras (1997), Smith, Kirchner, Taylor, Hoffman, and Lemke (1998), Smith, Lemke, Taylor, Kirchner, and Hoffman (1998), Smolander and Huttunen (2006), Thibeault, Merrill, Roy, Gray, and Smith (2004), Thomas, Kooijman, Cremers, and De Jong (2006), and Van Houtte, Claeys, Wuyts, and 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. (De Jong et al., 2006; Kooijman et al., 2006), Roy et al. (Roy, Merrill, Thibeault, Gray, et al., 2004; Roy, Merrill, Thibeault, Parsa, et al., 2004; Thibeault et al., 2004) and Smith et al. (Smith, Kirchner, et al., 1998; Smith, Lemke, et al., 1998). All of the publications met the inclusion criteria and were used for data extraction and methodological quality assessment.

### 2.3. 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.

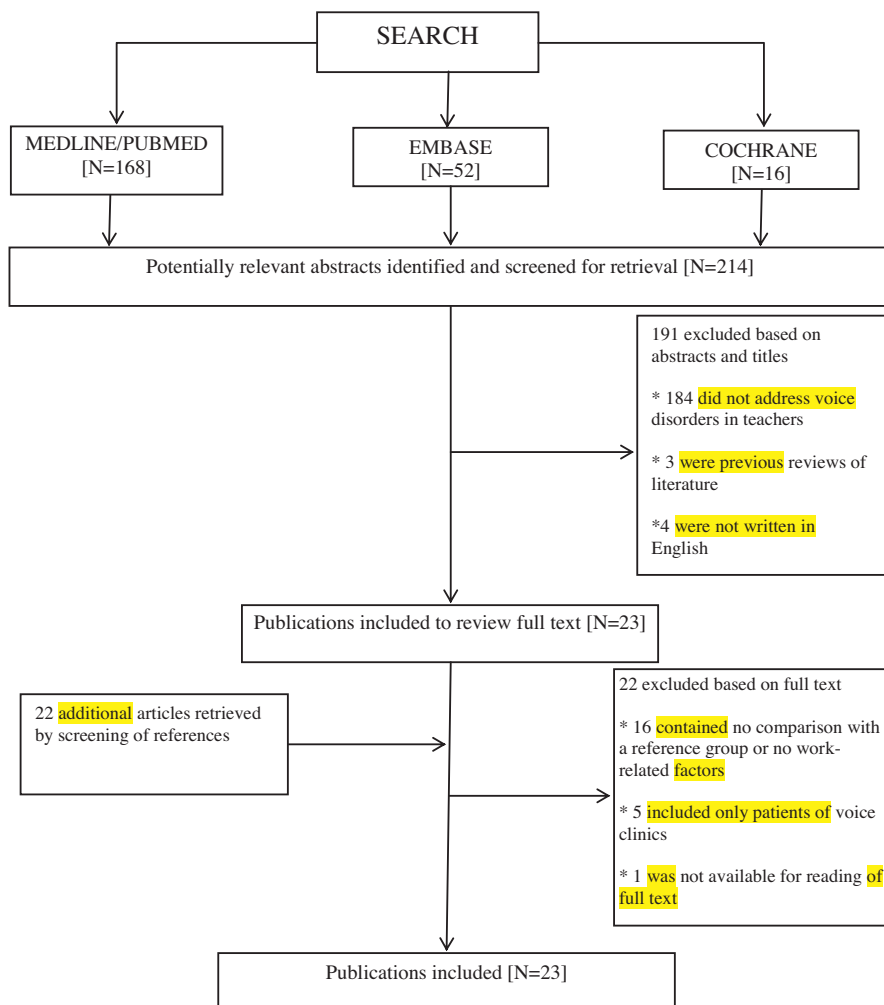


Fig. 1. Flow chart of the process for identification of included of publications.

The prevalence of voice disorders reported in 23 publications was classified in four categories: point (currently present), 12-month (present in the past year), life-time (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-month period) and a prevalence without a clearly defined recall period (life-time 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 (Bland & Altman, 2000). ORs were directly extracted from 14 publications: Angelillo et al. (2009), Chen et al. (2010), De Jong et al. (2006), De Medeiros et al. (2008), Kooijman et al. (2006), Miller and Verdolini (1995), Preciado-Lopez et al. (2008), Roy, Merrill, Thibeault, Parsa, et al. (2004), Sliwinska-Kowalska et al. (2006), Smith, Kirchner, et al. (1998), Smith, Lemke, et al. (1998), Smolander and Huttunen (2006), Thibeault et al. (2004), and Van Houtte et al. (2010). In 9 publications this information was not presented, and ORs were calculated based on the raw data provided: Ahlander et al. (2010); Chong and Chan (2010), Da Costa et al. (2010), Jonsdottir et al. (2002), Pekkarinen et al. (1992), Roy, Merrill, Thibeault, Gray, et al. (2004), Sala et al. (2001), Smith et al. (1997), and Thomas et al. (2006).

#### 2.4. 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 (Egger, Davey Smith, Schneider, & Minder, 1997).

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 (Wells et al., n.d.), 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 Appendix B and supplementary information. 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.

### 3. Results

#### 3.1. 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% (Smith, Kirchner, et al., 1998) to 37% (Thomas et al., 2006). The 12-month prevalence ranged from 15% (De Medeiros et al., 2008) to 80% (Pekkarinen et al., 1992). Three publications presented a clinically verified prevalence of voice disorders, ranging from 17% (Sala et al., 2001) to 57% (Preciado-Lopez et al., 2008).

Table 2 presents the studies with a prevalence of voice disorders during life-time or an unspecified recall period. In seven studies the life-time prevalence of voice disorders ranged from 51% (Angelillo et al., 2009) to 69% (Sliwinska-Kowalska et al., 2006), whereas in 10 publications on prevalence without a defined period the proportion of teachers with voice problems ranged between 13% (Jonsdottir et al., 2002) and 94% (Roy, Merrill, Thibeault, Gray, et al., 2004).

#### 3.2. 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 (Roy, Merrill, Thibeault, Gray, et al., 2004) to 4.61 (Sliwinska-Kowalska et al., 2006).

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 (Preciado-Lopez et al., 2008) and 5.18 (De Medeiros et al., 2008).

Associations between work organization and employment conditions with voice disorders were statistically significant in 8 publications. Three publications showed statistically significant associations between teaching physical education and voice disorders (Chong & Chan, 2010; Smith, Kirchner, et al., 1998; Smith, Lemke, et al., 1998).

**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		Voice disorder	Prevalence % (95% CI)
Study (first author/year/country)	Sample size		
<b>Point prevalence</b>			
Smith, Kirchner, et al. (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)
<b>12-month period prevalence</b>			
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)
<b>Clinically verified point prevalence</b>			
Sala (2001) (Finland)	262 (257 F–5 M)	LAR	17 (12–22)
Sliwiska-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		Voice disorder	Prevalence % (95% CI)
Study (first author/year/country)	Sample size		
<b>Life-time prevalence</b>			
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)
Sliwiska-Kowalska (2006) (Poland)	425 F	VS	69 (64–73)
<b>Prevalence with unspecified recall period</b>			
Jonsdottir (2002) (Iceland)	85 (35 F–50 M)	D	13 (6–20)
Smith, Kirchner, et al. (1998) (USA)	554 (274 M–280 F)	VS	32 (28–36)
Smith, Lemke, et al. (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, et al. (2004) (USA)	1243 (858 F–385 M)	VS	94 (92–95)

M, male; F, female; D, dysphonia; FG, fatigue; HS, hoarseness; VBR, voice breaks; VC, voice complaints; VD, voice disorder; VL, voice loss; VP, voice problems; VS, voice symptoms.

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 (Chen et al., 2010). 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 (Chen et al., 2010; Thomas et al., 2006).

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 (Chen et al., 2010; Roy, Merrill, Thibeault, Parsa, et al., 2004; Smith, Kirchner, et al., 1998; Smith, Lemke, et al., 1998; Smolander & Huttunen, 2006; Thibeault et al., 2004). In two publications it was possible to calculate crude ORs in order to compare adjusted and unadjusted ORs (Chen et al., 2010; Roy, Merrill, Thibeault, Parsa, et al., 2004). 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) (Roy, Merrill, Thibeault, Parsa, et al., 2004). Another study investigated the use of loud voice among teachers and reported an adjusted OR of 4.34, whereas the crude OR was 3.19 (Chen et al., 2010).

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

Category of prevalence Study (first author/year/country)	Study population teachers		Non teachers (reference)		Voice disorder	OR (95% CI)
	N	Prevalence (%)	N	Prevalence (%)		
<b>Point prevalence</b>						
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 <sup>a</sup>	3.20 (1.35–7.58)
Sliwinska-Kowalska (2006) (Poland)	425	33	83	10	VD <sup>a</sup>	4.61 (2.16–9.85)
<b>12-month prevalence</b>						
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)
<b>Life-time prevalence</b>						
Roy, Merrill, Thibeault, Parsa, et al. (2004) (USA)	1243	94	1158	89	VS	2.04 (1.55–2.68) <sup>b</sup>
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)
<b>Prevalence with unspecified recall period</b>						
Smith, Lemke, et al. (1998) (USA)	554	32	220	1	VP	1.20 (0.86–1.69) <sup>c</sup>
Roy, Merrill, Thibeault, Gray, et al. (2004) (USA)	1243	11	1288	6	VD	1.89 (1.41–2.53)

OR, odds ratio; D, dysphonia; HS, hoarseness; LAR, laryngitis; VC, voice complaints; VD, voice disorder; VP, voice problems; VS, voice symptoms; VT, voice tired.

<sup>a</sup> Clinical examination.

<sup>b</sup> Adjusted for age, gender, school grade and family history.

<sup>c</sup> 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	N	Work-related and individual factors	OR (95% CI)
<b>Working environment</b>				
<i>Acoustics and noise conditions</i>				
Ahlander (2010) (Sweden)	VP	467	7–15 vs. 1–6 students	0.27 (0.08–0.93)
			15–30 vs. 1–6 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)
<i>Ventilation</i>				
De Medeiros (2008) (Brazil)	D	2103	Reasonable vs. satisfactory	1.76 (1.26–2.44)
			Poor vs. satisfactory	2.84 (2.00–4.04)
<i>Lighting</i>				
De Medeiros (2008) (Brazil)	D	2103	Reasonable vs. satisfactory	1.76 (1.30–2.37)
			Poor vs. satisfactory	3.28 (2.18–4.93)
<i>Temperature</i>				
Kooijman (2006) (Netherlands)	VC	1878	Temperature change in classroom vs. no change	1.48
<i>Humidity</i>				
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)
<i>Irritants</i>				
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)
<b>Work organization and employment conditions</b>				
<i>Topic of teaching</i>				
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, et al., 1998 (USA)	VS	554	Physical education (yes vs. no)	3.70 (1.4–9.5) <sup>a</sup>
			Biology/chemistry (yes vs. no)	2.10 (0.9–5.3) <sup>a</sup>
Smith, Lemke, et al., 1998 (USA)	VP	554	Physical education (yes vs. no)	3.70 (1.45–9.47) <sup>a</sup>
Thibeault (2004) (USA)	VD	1243	Physical education (yes vs. no)	1.20 (0.8–1.8) <sup>b</sup>
			Chemical sciences (yes vs. no)	2.00 (1.1–3.4) <sup>b</sup>
			Drama (yes vs. no)	2.10 (0.9–4.8) <sup>b</sup>
			Vocal music (yes vs. no)	2.20 (1.2–4.0) <sup>b</sup>

**Table 4** (Continued)

Study (first author/year/country)	Voice disorder	N	Work-related and individual factors	OR (95% CI)
<i>Level of teaching</i>				
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)
<i>Weekly workload (h/class)</i>				
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)
<i>Gross annual income</i>				
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)
<b>Individual factors</b>				
<i>Voice use</i>				
Chen (2010) (Taiwan)	VP	117	Using loud voice in teaching (yes vs. no)	4.34 (1.44–13.14) <sup>d</sup>
Smolander (2006) (Finland)	VD	181	Voice use (shouting vs. not shouting)	2.8 (1.4–5.6) <sup>c</sup>
<i>Psychosocial aspects</i>				
Thomas (2006) (Netherlands)	VC	82	High work pressure (yes vs. no)	3.14 (1.88–5.27)
<i>Years in teaching</i>				
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; D, dysphonia; IGC, incomplete glottal closure; VC, voice complaints; VD, voice disorder; VP, voice problems; VS, voice symptoms.

<sup>a</sup> Adjusted for age, gender and hours taught/day.

<sup>b</sup> Adjusted for age, gender, and race/ethnicity.

<sup>c</sup> 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.

<sup>d</sup> Adjusted for age, years in occupation, grade taught, using amplification, number of bad vocal habits, number of diseases, head and neck surgeries.

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.

#### 4. 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 (Pekkarinen et al., 1992; Roy, Merrill, Thibeault, Gray, et al., 2004; Thomas et al., 2006). 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 (De Medeiros et al., 2008). 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 is needed. It is advised to adopt a well-defined recall period that should not exceed 12 months in order to avoid recall bias (Coughlin, 1990).

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 (Preciado-Lopez et al., 2008; Sliwiska-Kowalska et al., 2006) or indirect laryngoscopy (Sala et al., 2001). 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 (Behrman & Orlikoff, 1997; Sataloff, Hawkshaw, Divi, & Heman-Ackah, 2007).

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 language 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 (Zannin & Marcon, 2007); 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 (Astolfi & Pellerey, 2008; Hétu, Truchon-Gagnon, & Bilodeau, 1990; Zannin & Zwirnes, 2009). 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 (Kooijman et al., 2006). In contrast, another publication showed that teachers with larger class sizes were less likely to report voice disorders than teachers with smaller class size (Ahlander et al., 2010). 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 addresses 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. 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 (Angelillo et al., 2009). 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) (Sala et al., 2001). 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 (De Jong et al., 2006; Kooijman et al., 2006; Smith, Kirchner, et al., 1998). The distribution of voice disorders by gender may differ; some authors suggest that women report voice disorders more often than men (Smith, Kirchner, et al., 1998). 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 (Da Costa et al., 2010; De Medeiros et al., 2008), but other authors have reported an opposite relationship (Smith et al., 1997). 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 (Chong & Chan, 2010; Da Costa et al., 2010; Jonsdottir et al., 2002; Kooijman et al., 2006; Thomas et al., 2006). 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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## Conflict of interest statement

The authors of this article have not reported any financial or non-financial conflict of interest.



## Appendix A. Relevant data from the included publications

Study (first author/ year/country)	Study population	Sample size		Voice disorders definition <sup>a</sup>	Work-related factors <sup>b</sup>
		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. All teachers of 5 randomly selected elementary, middle, and high schools in Taipei City	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)	Primary and secondary school teachers randomly selected from the Hong Kong Professional Teacher's Union database	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)	Kindergarten teachers in North Carolina	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)	Elementary education daytime teachers from 83 schools	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
De Medeiros (2008) (Brazil)	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	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)	Elementary 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

Study (first author/ year/country)	Study population	Sample size		Voice disorders definition <sup>a</sup>	Work-related factors <sup>b</sup>
		Teachers	Non-teachers		
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 paresthesia, change in voice quality, voice breaks) and clinical examination with videolaryngoscopy: abnormal stroboscopic findings	Noise in classroom, echo in the classroom
Roy, Merrill, Thibault, Pansa, 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, Thibault, Gray, 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	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 centers 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 videostroboscopic 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, Lenke, et al. (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
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, et al. (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 school teachers 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

NL, not informed.

<sup>a</sup> All the studies measured prevalence of voice disorders with a questionnaire. When clinical examination was also used, this was specified.

<sup>b</sup> 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 (Wells et al., n.d.). The list has 19 items organized in 5 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 ( $\geq 13$ ), or low methodological quality ( $< 13$ ) according to their methodological quality scores (MQS).

Methodological quality assessment list. Based on Newcastle–Ottawa Quality Assessment Scale.

Item	Scoring options
<b>Study population</b>	
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 $\geq 70\%$ Positive = participation was $> 70\%$
3	Number of cases $\geq 50$ 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
<b>Assessment of work-related and or individual factors</b>	
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
<b>Assessment of voice disorder</b>	
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
<b>Study design and analysis</b>	
14	Type of study Positive = case control study
15	Inclusion and exclusion criteria Positive = criteria described
<b>Data presentation</b>	
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 ORs are adjusted for age and gender
19	Consideration of confounders Positive = confounders that were considered were described

## Appendix C. Continuing education

### CEU questions

- Voice disorders are more common among teachers than non-teachers.
  - True
  - False
- There is a large variation in reported prevalence of voice disorders among teachers.
  - True
  - False
- The point prevalence range is wider than the prevalence with unspecified recall period range.
  - True
  - False
- The relationship between class-size and voice disorders among teachers is unequivocal.
  - True
  - False
- The causality of the reported associations between working conditions and voice disorders among teachers could be established from the included publications.
  - True
  - False

## Appendix D. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jcomdis.2013.01.001>.

## References

- Ahlander, V., Rydell, R., & Lofqvist, A. (2010). Speaker's comfort in teaching environments: Voice problems in Swedish teaching staff. *Journal of Voice*, 25(4), 430–440.
- Alves, L., Do Carmo Cruz Robazzi, M., Marziale, M., De Felipe, A., & Da Conceicao Romano, C. (2009). Health disorders and teachers' voices: A workers' health issue. *Revista Latino-Americana de Enfermagem*, 17(4), 566–572.
- Angelillo, M., Di Maio, G., Costa, G., Angelillo, N., & Barillari, U. (2009). Prevalence of occupational voice disorders in teachers. *Journal of Preventive Medicine and Hygiene*, 50(1), 26–32.
- ASHA. *Definitions of communication disorders and variations [relevant paper]*. (1993). <http://www.asha.org/policy>.
- ASHA. *Evidence-based practice (EBP)*. (2004). <http://www.asha.org/members/ebp/> Accessed 15.05.2012.
- Astolfi, A., & Pellerey, F. (2008). Subjective and objective assessment of acoustical and overall environmental quality in secondary school classrooms. *Journal of the Acoustical Society of America*, 123(1), 163–173.
- Behrman, A., & Orlikoff, R. F. (1997). Instrumentation in voice assessment and treatment: What's the use? *American Journal of Speech-Language Pathology*, 6(4), 9–16.
- Betancourt, O. (1999). *Para la enseñanza y la investigación de la salud y seguridad en el trabajo*. Quito, Ecuador: Ed. OPS/OMS-FUNSA.
- Bland, J. M., & Altman, D. G. (2000). The odds ratio. *BMJ*, 320(7247), 1468.
- Chen, S., Chiang, S., Chung, Y., Hsiao, L., & Hsiao, T. (2010). Risk factors and effects of voice problems for teachers. *Journal of Voice*, 24(2), 183–190, quiz 191–182.
- Chong, E., & Chan, A. (2010). Subjective health complaints of teachers from primary and secondary schools in Hong Kong. *International Journal of Occupational Safety and Ergonomics*, 16(1), 23–39.
- Coughlin, S. S. (1990). Recall bias in epidemiologic studies. *Journal of Clinical Epidemiology*, 43(1), 87–91, doi:10.1016/0895-4356(90)90060-3.
- Da Costa, V., Prada, E., Roberts, A., & Cohen, S. (2010). Voice disorders in primary school teachers and barriers to care. *Journal of Voice*, 26(1), 69–76.
- De Jong, F., Kooijman, P., Thomas, G., Huinck, W., Graamans, K., & Schutte, H. (2006). Epidemiology of voice problems in Dutch teachers. *Folia Phoniatica et Logopedica*, 58(3), 186–198.
- De Medeiros, A., Barreto, S., & Assuncao, A. (2008). Voice disorders (dysphonia) in public school female teachers working in Belo Horizonte: Prevalence and associated factors. *Journal of Voice*, 22(6), 676–687.
- Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple graphical test. *BMJ*, 315(7109), 629–634.
- Euromond. *Working conditions*. (2011). <http://www.euromond.europa.eu/areas/industrialrelations/dictionary/definitions/WORKINGCONDITIONS.htm> Accessed 04.04.2011.
- Hétu, R., Truchon-Gagnon, C., & Bilodeau, S. A. (1990). Problems of noise in school settings: A review of literature and the results of an exploratory study. *Journal of Speech-Language Pathology and Audiology*, 14(3), 31–39.
- Ilomaki, I., Leppanen, K., Kleemola, L., Tyrmi, J., Laukkanen, A., & Vilkmán, E. (2009). Relationships between self-evaluations of voice and working conditions, background factors, and phoniatic findings in female teachers. *Logopedics, Phoniatrics, Vocology*, 34(1), 20–31.
- Jonsdottir, V., Boyle, B., Martin, P., & Sigurdardottir, G. (2002). A comparison of the occurrence and nature of vocal symptoms in two groups of Icelandic teachers. *Logopedics, Phoniatrics, Vocology*, 27(3), 98–105.
- Kooijman, P., De Jong, F., Thomas, G., Huinck, W., Donders, R., Graamans, K., et al. (2006). Risk factors for voice problems in teachers. *Folia Phoniatica et Logopedica*, 58(3), 159–174.
- Mattiske, J., Oates, J., & Greenwood, K. (1998). Vocal problems among teachers: A review of prevalence, causes, prevention, and treatment. *Journal of Voice*, 12(4), 489–499.
- Miller, M. K., & Verdolini, K. (1995). Frequency and risk factors for voice problems in teachers of singing and control subjects. *Journal of Voice*, 9(4), 348–362.
- Pekkarinen, E., Himberg, L., & Pentti, J. (1992). Prevalence of vocal symptoms among teachers compared to nurses—a questionnaire study. *Scandinavian Journal of Logopedics and Phoniatrics*, 17, 112–117.
- Preciado-Lopez, J., Perez-Fernandez, C., Calzada-Uriondo, M., & Preciado-Ruiz, P. (2008). Epidemiological study of voice disorders among teaching professionals of La Rioja, Spain. *Journal of Voice*, 22(4), 489–508.
- Roy, N., Merrill, R., Thibeault, S., Gray, S., & Smith, E. (2004). Voice disorders in teachers and the general population: Effects on work performance, attendance, and future career choices. *Journal of Speech, Language, and Hearing Research*, 47(3), 542–551.
- Roy, N., Merrill, R., Thibeault, S., Parsa, R., Gray, S., & Smith, E. (2004). Prevalence of voice disorders in teachers and the general population. *Journal of Speech, Language, and Hearing Research*, 47(2), 281–293.
- Sala, E., Laine, A., Simberg, S., Pentti, J., & Suonpää, J. (2001). The prevalence of voice disorders among day care center teachers compared with nurses: A questionnaire and clinical study. *Journal of Voice*, 15(3), 413–423.
- Sataloff, R. T., Hawkshaw, M. J., Divi, V., & Heman-Ackah, Y. D. (2007). Physical examination of voice professionals. *Otolaryngologic Clinics of North America*, 40(5), 953–969, doi:10.1016/j.otc.2007.05.004.
- Sliwinska-Kowalska, M., Niebudek-Bogusz, E., Fiszer, M., Los-Spychalska, T., Kotylo, P., Sznurowska-Przygocka, B., et al. (2006). The prevalence and risk factors for occupational voice disorders in teachers. *Folia Phoniatica et Logopaedica*, 58(2), 85–101.
- Smith, E., Gray, S., Dove, H., Kirchner, L., & Heras, H. (1997). Frequency and effects of teachers' voice problems. *Journal of Voice*, 11(1), 81–87.
- Smith, E., Kirchner, H., Taylor, M., Hoffman, H., & Lemke, J. (1998). Voice problems among teachers: Differences by gender and teaching characteristics. *Journal of Voice*, 12(3), 328–334.
- Smith, E., Lemke, J., Taylor, M., Kirchner, H., & Hoffman, H. (1998). Frequency of voice problems among teachers and other occupations. *Journal of Voice*, 12(4), 480–488.
- Smolander, S., & Huttunen, K. (2006). Voice problems experienced by Finnish comprehensive school teachers and realization of occupational health care. *Logopedics Phoniatrics Vocology*, 31(4), 166–171.
- Thibeault, S., Merrill, R., Roy, N., Gray, S., & Smith, E. (2004). Occupational risk factors associated with voice disorders among teachers. *Annals of Epidemiology*, 14(10), 786–792.
- Thomas, G., Kooijman, P., Cremers, C., & De Jong, F. (2006). A comparative study of voice complaints and risk factors for voice complaints in female student teachers and practicing teachers early in their career. *European Archives of Oto-Rhino-Laryngology*, 263(4), 370–380.
- Van Houtte, E., Claeys, S., Wuyts, F., & Van Lierde, K. (2010). The impact of voice disorders among teachers: vocal complaints, treatment-seeking behavior, knowledge of vocal care, and voice-related absenteeism. *Journal of Voice*, 25(5), 570–575.
- Vilkmán, E. (2000). Voice problems at work: A challenge for occupational safety and health arrangement. *Folia Phoniatica et Logopedica*, 52(1–3), 120–125.
- Vilkmán, E. (2004). Occupational safety and health aspects of voice and speech professions. *Folia Phoniatica et Logopedica*, 56(4), 220–253.
- Wells, G., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., et al. (n.d.). *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. [http://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) Accessed 01.04.2011.
- Williams, N. (2003). Occupational groups at risk of voice disorders: A review of the literature. *Occupational Medicine (London)*, 53(7), 456–460.
- Zannin, P. H. T., & Marcon, C. R. (2007). Objective and subjective evaluation of the acoustic comfort in classrooms. *Applied Ergonomics*, 38(5), 675–680, doi:10.1016/j.apergo.2006.10.001.
- Zannin, P. H. T., & Zwirter, D. P. Z. (2009). Evaluation of the acoustic performance of classrooms in public schools. *Applied Acoustics*, 70(4), 626–635, doi:10.1016/j.apacoust.2008.06.007.