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Voice Problems in Teachers: Prevalence, Risk Factors, and Vocal Loading

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*A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of
Philosophy (PhD) in Speech Science, The University of Auckland, 2016.*

Abstract

Aims: This research determined: a) prevalence of voice problems in New Zealand teachers; b) factors associated with voice problems and voice related quality of life in teachers; c) whether there are differences in vocal load and environmental noise levels and acoustic parameters of classrooms between primary and secondary teachers with and without self-reported voice problems; d) changes in voice use over the teaching day; and e) correlations between vocal load, voice self-assessment, and environmental measures.

Methods: The first two studies were cross-sectional online surveys. In study 1, participants were 1879 primary and secondary teachers (72.5% females). Three time-frames were used to determine prevalence of self-reported voice problems (day of survey, previous teaching year, career). Severity of voice problems, recovery time, days away from work, symptoms, health assistance, and voice education were also investigated. Study 2 used multivariate analyses to identify factors associated with voice-related quality of life and voice problems in 572 teachers (74% females). A range of potential antecedent factors including demographic, teaching related, voice related, environmental, psychosocial, health, and lifestyle factors were explored. Regression models were determined for frequency and severity of voice problems, V-RQOL scores, voice symptoms, and voice quality. Study 3 used vocal and noise dosimetry over two teaching days in 16 teachers with voice problems and 14 controls.

Results: Study 1: Prevalence of self-reported vocal problems was 33.2% over teaching careers, 24.7% over the year, and 13.2% on the day of the survey. Voice problems were more prevalent in primary teachers ($p < .001$; OR=1.74; CI=1.33-2.40), females ($p = .008$; OR=1.63; CI=1.13-2.37), and those aged 51-60 years ($p = 0.010$; OR=1.45; CI=1.11-3.00). Among teachers reporting voice problems during the year, 47% were moderate/severe and 30% took more than 1 week to recover. Approximately 28% of teachers stayed away from work 1-3 days due to a vocal problem and 9% stayed away > 3 days. Symptoms associated with voice problems ($p < .001$) were voice quality alteration (OR=4.35; CI=3.40-5.57), vocal

effort (OR=1.15; CI=0.96-1.37), voice breaks (OR=1.55; CI=1.30-1.84), projection difficulty (OR=1.25; CI=1.04-1.50), and throat discomfort (OR=1.22; CI=1.02-1.47). Only 22.5% with voice problems consulted health practitioners. More voice training/education was associated with fewer voice problems. **Study 2:** Multivariate analyses revealed associations between teaching demographics, voice use, environmental and psychosocial factors, health and voice problems and voice-related quality of life; significant factors included harmful voice use, reflux symptoms, classroom noise, stress, lower hours of voice education/training and voice rest, upper respiratory tract infections, exposure to chemicals, extraversion, self-efficacy, job satisfaction, openness to experience, agreeableness, and avoidance coping behavior. **Study 3:** The voice problem group had higher phonation time, and spoke more quietly than controls. Peak classroom noise levels were greater for controls. All teachers showed increased F0, decreased phonation time, and decreased LAeq median noise levels over the day and positive correlations between F0 and voice SPL, environmental noise levels and voice SPL. Several vocal load parameters correlated with voice self-ratings. **Conclusions:** Voice problems are prevalent for teachers in New Zealand, as is the case in other countries. Teachers with voice problems spoke for longer periods and more quietly, and had more frequent and more severe symptoms than teachers without voice problems. There is limited awareness among teachers about vocal health, potential risks, and health services for voice problems. This research highlighted the need for voice education and training programmes and provides evidence for their development through identification of vocal behaviors and other voice risk factors for teachers.

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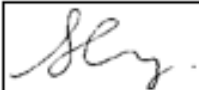



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A handwritten signature in black ink, appearing to read "Randall P Morton", with a horizontal line underneath.

21/09/2015

Chapter 1: Introduction

The human voice and its features

The human voice is a complex and powerful communication tool. One of the basic roles of the human voice is to provide the major sound source for speech and singing, through vocal fold vibration and vocal tract resonance. In addition to conveying thoughts, the pivotal role of voice, the voice has other important roles in human daily life (Aronson & Bless, 2009; Colton, Casper, & Leonard, 2011; Mathieson, 2001). By varying pitch, loudness, quality, resonance, and speech rhythm and rate, the voice produces music and can express emotion, mood, persuade or dissuade, influence the emotional state of others, command/get attention, attract or repel people, and communicate the subtleties/refinements of meaning and intention. In addition, considerable information about a speaker's characteristics can be acquired from the voice such as the speaker's sex, age, personality, attitudes, social status and physical and psychological health (Oates, 2011; Williams & Carding, 2005).

Most of us would struggle without an effective voice in our daily life. Despite this, little time or effort is spent ensuring that one's voice performs at maximum efficiency and people typically barely notice how difficult and unpleasant it is to speak in the presence of a cold and when other voice difficulties such as hoarseness occur (Williams & Carding, 2005).

Voice problems

Voice problems are associated with a number of symptoms and signs (Aronson & Bless, 2009; Colton et al., 2011; Oates, 2004). Common symptoms reported by speakers with voice difficulties include changes in voice quality, pitch, loudness and resonance. Individuals with voice problems may also report vocal fatigue, pain, throat discomfort, increased vocal effort and/or other negative sensations related to voice use. The signs of a voice problem can be seen as perceptual, acoustic, aerodynamic and physiological changes in voice function.

Establishing whether a voice is normal or impaired is not straightforward (Oates, 2011). Colton et al. (2011) identified a voice problem as related to any difficulty in phonation,

deviant voice qualities, and/or physical pain or sensation related to voice use. A voice disorder has been defined as being present when voice “quality, pitch, loudness, or flexibility differs from those of similar age, sex, and cultural group” (Aronson & Bless, 2009, p. 5). This concept is not fixed or uniform, however, and there is no absolute criterion established for normality. There is wide inter-individual variation in voice and a range of ‘abnormal-sounding’ voices may be accepted depending on the speaker’s occupational and social status, and ethnic and cultural expectations. Thus an abnormal sounding voice does not automatically imply a voice disability (Aronson & Bless, 2009).

Throughout this thesis, the term ‘voice problem’ is used to encompass a range of voice attributes and voice-related difficulties, incorporating the concepts of voice disorder described above and the impact of voice problems on the individual.

Occupational voice disorders

Occupational disease is “any disease contracted primarily as a result of an exposure to risk factors arising from work activity” (WHO, 2015a). Occupational voice disorders occur when the individual’s voice does not meet the profession’s criteria and demands (Vilkman, 2004). The aetiology of occupational voice disorders, as is the case for most voice problems, is multifactorial. The work environment may play an important role along with other risk factors in the development of voice disorders (Vilkman, 2004).

Interest in occupational vocal health has been growing, in part due to the increasing number of professionals who rely on their voice as their main tool for working (Epstein, Remacle, & Morsomme, 2011; Rantala, Vilkman, & Bloigu, 2002). However, the occupational voice area is still underdeveloped in comparison to occupational hearing loss and other work-related conditions (Rantala et al., 2002). In the hearing occupational health area, for instance, the safe dose criterion for noise-induced loss is well established (International Organization for Standardization, 2013), while in the voice field, it is still unclear what the safe vocal dose is for those whose voices are their main work tool (Dejonckere, 2001; Epstein et al., 2011). Studies of long-term voice use using vocal

dosimeters have been conducted to better understand the relationship between voice problems and vocal load, and to establish safe vocal doses. However, there is a need for long-term monitoring studies involving individuals with voice problems and objective environmental measures to expand knowledge in this area. Furthermore, the relationship between risk factors and voice problems must be better understood in order to improve vocal health and safety (Vilkman, 2000, 2004).

International Classification of Functioning, Disability and Health (ICF)

Voice problems can have a considerable impact on the functioning and health of people, especially for those who rely on their voice to work. A new perspective on health and disability introduced by the World Health Organization (WHO) in 2001, the International Classification of Functioning, Disability and Health (ICF), proposed that health and disability research should shift from the focus on physical aspects of health to the wider impact that a health condition has on the individual. In this view, health is viewed as multidimensional and as a combination of physical, psychological, and wellbeing factors. The ICF was developed to provide a unified and standardised language and framework for describing of health and health-related states, incorporating the perspectives of the body, the individual and society (WHO, 2001). The ICF has two main subdivisions: Functioning and Disability, which includes Body Functions and Structures, and Activities and Participation; and Contextual Factors, which includes Environmental and Personal Factors. The ICF can be applied as a statistical tool (e.g. collection and recording data), a clinical tool (e.g. outcomes evaluation, needs assessment), a social policy tool (e.g. policy design and implementation), an education tool (e.g. curricular design), and in the research field, a tool for measuring outcomes, quality of life and environmental factors influencing health. In the voice disorders field, a number of self-assessment instruments have been developed to assess vocal impairment and its impact on the individual's life, in line with the ICF framework. These include the Voice Handicap Index (VHI) (Jacobson et al., 1997), Voice-Related Quality of Life (V-RQOL) (Hogikyan & Sethuraman, 1999), Voice Performance Questionnaire (Carding, Horsley, & Docherty,

1999), Voice Activity and Participation Profile (VAPP) (Ma & Yiu, 2001), Voice Symptom Scale (VoiSS) (Deary, Wilson, Carding, & MacKenzie, 2003b). Ma, Yiu and Verdolini (2007) listed important ICF codes and descriptions to be used for voice problems, such as s110-vocal folds (body structures), b3101-quality of voice (body functions), d350-conversation, d850-remunerative employment (activities and participation), e260-air quality and e580-health services, systems and policies (environmental factors) (Ma, Yiu, & Verdolini, 2007).

In line with the ICF, Vilkmán (2004) recommended that voice disorders need to be seen from an occupational point of view as occurring when the individual's voice does not meet their occupational criteria and demands. Vocal endurance is a crucial aspect of vocal health. Vocal demands differ among occupational groups, in terms of working ability; for instance, for school and kindergarten teachers, vocal loading can be more important than vocal quality as teachers need to be able to speak for long periods over the school day. In contrast, for singers, voice quality can be more critical (Vilkmán, 2004). In the ICF framework, the need for treatment is determined by whether or not an individual experiences limitations of their activity and participation as a result of a voice problem. Limitation of activities can potentially be resolved by modifying the environment and personal factors as well as directly treating the voice impairment (Vilkmán, 2004).

Voice problems in teachers

Voice problems can affect work capacity in professions with heavy vocal loading, such as school teaching. The voice is the main tool for teaching work and needs to be effective and flexible in a wide range of circumstances and, for the majority, almost every day of the week. Teaching is a stressful profession (Naghieh, Montgomery, Bonell, Thompson, & Aber, 2015) with high work load, heavy vocal demands, and few periods of voice rest. In addition, teachers often work in environments with poor acoustic and air quality. There is evidence that teachers have a higher risk of developing voice disorders and other vocal problems than other occupations and the general population (Behlau, Zambon, Guerrieri, & Roy, 2012; De Jong et al., 2006; Mattiske, Oates, & Greenwood, 1998; Roy,

Merrill, Thibeault, Gray, & Smith, 2004; Russell, 1999; Russell, Oates, & Greenwood, 2005; Russell, Oates, & Greenwood, 1998; Smith, Lemke, Taylor, Kirchner, & Hoffman, 1998; Thibeault, Merrill, Roy, Gray, & Smith, 2004; Van Houtte, Claeys, Wuyts, & Van Lierde, 2011; Vilkman, 2000).

Voice disorders in teachers may lead to absence from work, lost income, changes in teaching style and quality, prolonged rehabilitation periods, and in more severe cases, the teacher with a voice disorder may need to change professions and face early career termination (Roy, Merrill, Thibeault, Gray, et al., 2004; Smith, Gray, Dove, Kirchner, & Heras, 1997; Smith, Lemke, et al., 1998; Van Houtte, Claeys, et al., 2011). Voice disorders may also impact teachers' psychological and social status (Yiu, 2002). Voice problems have been identified as one of the main reasons for absenteeism in teachers (Mattiske et al., 1998), increasing costs for the educational system, due to the need to appoint relieving teachers (Pemberton, Oates, & Russell, 2010) and there are other indirect costs such as compromised student learning, and costs to the health system associated with rehabilitation and potential surgery. Furthermore, there is evidence that students' learning is also affected by their teacher's unhealthy voice (Lyberg-Åhlander, Brännström, & Sahlén, 2015; Rogerson & Dodd, 2005).

Prevalence of voice problems in teachers

The impact of voice disorders in the workplace can be quantified by examining incidence and prevalence in different occupational groups compared to the general population (Epstein et al., 2011). In the general population, the reported prevalence rates varies from 3% to 7.5% on the day of survey, 4% during the previous year, 7% during adult life, and 29%-36% across the lifespan (Behlau et al., 2012; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 2005). Figures are higher in the teaching population with reported prevalence of voice problems in teachers varying widely, ranging from 4.4% to 90% (Behlau et al., 2012; De Jong et al., 2006; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998; Sliwinska-Kowalska et al., 2006; Smith et al., 1997; Smith, Lemke, et al., 1998; Van

Houtte, Claeys, et al., 2011). This variability in prevalence rates reflects differences in research methodology, including the definition of what constitutes a vocal problem, assessment instruments, the specified time period for vocal symptoms, and the sampling procedure. Studies with similar methodology conducted in Australia, USA, and Brazil show more consistent prevalence rates of 11-16% on the day of the survey than other studies (Behlau et al., 2012; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998). Prevalence across the lifespan is reported as 58%-63% (Behlau et al., 2012; Roy, Merrill, Thibeault, Gray, et al., 2004), 19% during the teaching career, and 20% during the teaching year (Russell et al., 1998). Although the prevalence of voice problems worldwide is well documented, there are no data on the prevalence of voice problems in teachers in New Zealand (NZ). The study which is presented as Chapter 2 in this thesis determined the prevalence of voice problems in NZ teachers and discusses the prevalence of voice problems in more detail.

Types of voice disorders in teachers

Symptoms reported by teachers vary across studies, with the most common symptom reported being change in voice quality (e.g. hoarseness), vocal fatigue/tired voice, changes in volume, and throat discomfort (Behlau et al., 2012; Nerrière, Vercambre, Gilbert, & Kovess-Masféty, 2009; Pekkarinen, Himberg, & Pentti, 1992; Rantala, Hakala, Holmqvist, & Sala, 2012; Roy, Merrill, Thibeault, Gray, et al., 2004; Smith et al., 1997; Smith, Lemke, et al., 1998). Compared to the general population, teachers are significantly more likely to report vocal fatigue, effort and discomfort when speaking, symptoms that more related to the physical sensations of voice production (Behlau et al., 2012).

Only a limited number of studies have investigated the prevalence of laryngeal pathologies and the types of clinical voice disorders in teachers. Most such studies have involved a large number of occupational voice users, with teachers as a subgroup (in most cases teachers were the largest group, however). Another important point is that in most studies, the data were obtained from a clinical case load and hence the findings of these

studies reflect the situation for the treatment-seeking population rather than the general population. Thus these studies are unlikely to reflect the 'true' prevalence of laryngeal pathologies and voice problems in the wider teaching population. Teachers may not seek treatment until symptoms are severe and are limiting their work or having a significant impact on their quality of life. Studies involving teachers and other occupational groups have identified functional problems as the most common vocal pathology (Fritzell, 1996; Urrutikoetxea, Ispizua, & Matellanes, 1994; Van Houtte, Van Lierde, D'haeseleer, & Claeys, 2010). In a large study involving 1046 teachers, Urrutikoetxea (1995) quantified visible laryngeal lesions in the vocal folds and found that 20.8% of the teachers had structural alterations (with the highest occurrence for vocal nodules). Fritzell et al. (1996) examined 1212 individuals (16% teachers) and the most frequently documented voice disorder was hyperfunctional voice disorder (referred to as phonoasthenia in this study), followed by vocal nodules, and then vocal fold oedema. Among the occupational voice users studied by Van Houtte (2009), 56% of whom were teachers, functional dysphonia was the most common pathology (41%), followed by vocal nodules (15%) and reflux laryngitis (11%). Although there is some variation in definitions of functional voice disorder across studies, it seems that muscle-based (hyperfunctional) voice problems are the most common problems reported by occupational voice users, including teachers. Hyperfunctional voice problems are thought to be caused by: a) vocal misuse/abuse (Koufman & Blalock, 1988, 1991; Morrison & Rammage, 1993), b) psychological and/or personality factors that tend to elevate perilaryngeal muscle tension (Rammage, Nichol, & Morrison, 1987; Roy & Bless, 2000; Roy, Bless, & Heisey, 2000a), or c) as compensation for underlying disease such as reflux or as a learned mechanism after upper respiratory tract infections (Koufman, Amin, & Panetti, 2000; Koufman & Blalock, 1982).

Voice function is multidimensional and therefore should be assessed using a range of measures (Hirano, 1989), including physiological, perceptual, acoustic, and aerodynamic measures and self-assessment questionnaires. Most previous studies of teachers' voices have used self-report questionnaires to evaluate voice use and related symptoms along with

perceptual, acoustic and physiological measures assessed in a clinical setting, to identify variables associated with voice problems in teachers (Laukkanen, Ilomäki, Leppänen, & Vilkmán, 2008; Laukkanen & Kankare, 2006; Smith et al., 1997). In the occupational voice use area, knowledge of environmental factors affecting voice and voice use at work is also needed to improve understanding of individual teachers' vocal functioning.

Epidemiological studies versus lab based versus field studies of voice

Although epidemiological studies based on questionnaires are able to estimate prevalence rates and determine factors associated with voice problems, empirical studies involving practical and objective measures in field conditions are needed to better characterise contributing factors such as vocal load and environmental factors and the effects of voice disorders in teachers. Studies have investigated vocal loading and environmental effects on teachers' voice in a laboratory context (Åhlander, Rydell, & Löfqvist, 2012; Vilkmán, Lauri, Alku, Sala, & Sihvo, 1997; Vintturi et al., 2001; Vintturi, Alku, Sala, Sihvo, & Vilkmán, 2003). More recently researchers have examined vocal load (long-term monitoring) during actual teaching practice (Åhlander, García, Whitling, Rydell, & Löfqvist, 2014; Ilomaki et al., 2009; Lehto, Laaksonen, Vilkmán, & Alku, 2006; Morrow & Connor, 2011; Rantala, Paavola, Korkko, & Vilkmán, 1998; Rantala et al., 2002; Remacle, Morsomme, & Finck, 2014; I. R. Titze, Hunter, & Svec, 2007). Teachers' voice use in action in their teaching environment is the most ecological way to assess vocal loading and other work-related factors. Åhlander and colleagues (2011) compared a group of teachers with voice problems to a group of healthy colleagues using a number of voice measures in the lab and clinic and no differences were found, suggesting that the distinction between the groups may more likely be found in field studies of voice use during teaching. It is expected that field studies will provide more ecologically valid objective evidence of occupational voice disorders diagnosed in clinical settings (Vilkmán, 2004).

Risk factors for voice disorders in teachers

“A risk factor is any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury” (WHO, 2015b). A wide range of risk factors for the development of voice disorders in teachers have been discussed in the literature (Kooijman et al., 2006; Rantala et al., 2012; Roy, Merrill, Thibeault, Gray, et al., 2004; Thibeault et al., 2004; Van Houtte, Claeys, Wuyts, & Van Lierde, 2012).

Epidemiological studies have identified a number of direct or indirect variables associated with voice problems in teachers, such as the vocal demands of the profession, gender, age, family history of vocal problems, teaching work related aspects (e.g. length of teaching career, teaching subject), vocal behavior/abuse, environment, upper respiratory disease/allergies, depression/stress, and lifestyle (Åhlander, Rydell, & Löfqvist, 2011; Medeiros, Barreto, & Assunção, 2008; Rantala et al., 2012; Roy, Merrill, Thibeault, Gray, et al., 2004; Russell, 1999; Russell et al., 1998). Russell (1999) reported that all teachers, no matter what specialty or where they teach, have high vocal demands, and that general health, vitality, vocal abuse were strong predictors of voice problems. Laboratory and field based studies have revealed that background noise, long speaking distance between the speaker and listener (Ilomaki et al., 2009), poor room acoustics, poor working posture, poor air quality (dryness, dust), and vocal load (Åhlander et al., 2014; Rantala et al., 2012; Vilkmán, 2004) can be associated with voice problems in teachers. The more ergonomic risks (related to working culture, noise, indoor air quality, working posture, stress, and access to a sound amplifier) that teachers are exposed to, the greater are the voice symptoms reported by teachers and the poorer the VHI scores (Rantala et al., 2012). Vilkmán (2004) suggested that other contributing individual factors include gender, health conditions, life habits, vocal skills, constitutional vocal endurance, and psychoemotional and personality factors and recommended that field studies involving such variables are needed.

Demographic characteristics such as gender and age have been widely examined, with female teachers being more likely to report voice problems (Roy, Merrill, Thibeault,

Gray, et al., 2004; Russell et al., 1998). Regarding age, there is some variability across studies. A few studies have reported that older teachers (usually older than 40 years) are at higher risk than younger teachers (Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998), while others have found that teachers at the beginning of their careers were more likely to report vocal complaints (Thomas, Kooijman, Donders, Cremers, & de Jong, 2007).

Teaching profession-related factors such as length of teaching career, teaching level, teaching subject, working hours, and income have been also linked with voice problems (Da Costa, Prada, Roberts, & Cohen, 2012; De Jong et al., 2006; Medeiros et al., 2008; Smith et al., 1997; Thibeault et al., 2004; Ubillos, Centeno, Ibañez, & Iraurgi, 2015). The association between voice problems and increased years in the teaching profession has been somewhat controversial. A few authors have found that increased years in the teaching profession is associated with voice problems (Da Costa et al., 2012; Medeiros et al., 2008; Roy, Merrill, Thibeault, Parsa, et al., 2004). However, younger teachers and teachers in training may have high rates of vocal complaints because of lack of training. Teachers who remain in their career longer may have better vocal endurance. Across teaching subjects, it has been reported that teachers who teach vocal music, drama, other performing arts, chemistry (Thibeault et al., 2004), physical education (S. H. Chen, Chiang, Chung, Hsiao, & Hsiao, 2010; Jónsdóttir, Boyle, Martin, & Sigurdardóttir, 2002; Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998; Smith, Lemke, et al., 1998), and biology/chemistry (Smith, Kirchner, et al., 1998) (Smith, Kirchner, 1998) are at increased risk for developing voice problems. Other factors such as the number of students in classroom have also been investigated, especially because more students in the room is likely to increase background noise. Only a few authors, however, have found a significant association between increased number of students and voice problems (e.g. Kooijman, 2006). Kooijman et al. (2006) found higher risk for teachers who have larger classroom sizes while the opposite result was reported by Åhlander et al. (2010).

Voice problems, such as those commonly found in teachers, are thought to be caused by vocal abuse, misuse or overuse that can lead to increased vibrational stress in

the vocal folds and changes in perilaryngeal muscle function and posture. Examples of harmful voice behaviors or patterns are speaking or singing with excessive loudness or pitch, shouting, yelling, and strained or effortful speaking/singing. Seminal studies have reported an association between these voice patterns and hyperfunctional voice problems (Koufman & Blalock, 1988, 1991; Morrison & Rammage, 1993). Teachers who use voice patterns such as speaking loudly and shouting have been shown to be at higher risk for developing voice problems. Lack of voice training has also been identified as a risk factor for developing voice problems (Vilkman, 2004); lack of training may result in harmful voice use patterns.

Environmental factors play an important role in occupational voice disorders. In teachers, poor room acoustics (Kooijman et al., 2006; Medeiros et al., 2008), poor air quality (e.g. poor ventilation, dust, humidity, temperature variation) (Geneid et al., 2009; Kooijman et al., 2006; Medeiros et al., 2008; Sliwinska-Kowalska et al., 2006), and poor lighting (Medeiros et al., 2008) are associated with increased risk of voice problems. A noisy teaching environment and poor room acoustics (which also may increase noise levels) can lead to a rise in the teacher's voice level (in order to achieve an adequate signal to noise ratio for teaching) and increased vocal effort (Brunskog, Gade, Bellester, & Calbo, 2009; Kob, Behler, Kamproff, Goldschmidt, & Neuschaefer-Rube, 2008; Kristiansen et al., 2014). Poor air quality may cause irritation of laryngeal tissues, and increase the chances of laryngitis (Rantala et al., 2012).

Psychosocial factors may also play an important role in the development and/or maintenance of the type of voice problems reported by teachers, however very few studies have addressed these factors. Teachers usually work in a stressful environment, with high vocal loading and psychological demands (Vilkman 2004). A number of studies have shown an association between psychological and/or personality factors and voice disorders (Rammage et al., 1987; Roy & Bless, 2000; Roy, Bless, & Heisey, 2000b). Individuals with common voice disorders, especially women, have been reported to experience increased levels of stress, anxiety, depression (Dietrich, Abbott, Gartner-Schmidt, & Rosen, 2008).

Teachers with voice problems experience greater stress, anxiety, and lower job satisfaction than their vocally health peers (Alvear, Martínez, Barón, & Hernández-Mendo, 2010; S. H. Chen et al., 2010; Gassull, Casanova, Botey, & Amador, 2010; Nerrière et al., 2009; Van Houtte et al., 2012). Certain personality features and temperaments may predispose individuals to certain voice problems. For example (Roy & Bless, 2000; Roy et al., 2000a) found that most individuals with functional dysphonia were introverts, while people with vocal nodules were extraverted. How an individual copes with stressful life events, communication needs, and health problems in general may be linked to voice problems and hence self-efficacy and coping may be linked to the onset and development of voice problems (Van Wijck-Warnaar et al., 2010).

All of these different types of risk factors may interact with each other in complex ways. It is therefore important that future studies of teachers' voice problems use multivariate analyses to more comprehensively investigate factors associated with voice problems.

Measuring vocal load

Heavy vocal load has been identified as a major contributing factor for voice problems in teachers. The concept of vocal loading developed by Vilkman (2004) was summarized by Hunter and Titze (2010, p. 862) as follows: "Vocal loading is a term used to quantify the demands placed on the vocal mechanism by the way the voice is used and the extent to which it is used". Extended prolonged voice use or vocal misuse may lead to excessive tissue vibration in the larynx (I. R. Titze, 1994) and/or to changes in perilaryngeal muscle function (Vilkman, 2004) and posture. Long periods of vocal use combined with high fundamental frequency imply a high number of vocal fold collisions per unit time, which may contribute to one aspect of vocal fatigue – the constant alteration/deformation of one layer of the vocal folds, the lamina propria (Roy, Merrill, Thibeault, Gray, et al., 2004; Russell et al., 1998; Sapir, Keidar, & Mathers-Schmidt, 1993b; Smith et al., 1997; I. R. Titze et al., 2007; Vilkman, 2004). Titze et al. (2007) hypothesized that vocal fatigue in teachers is attributable

to the fact that teachers speak largely in a monologue style, which leads to limited opportunities for voice rest during teaching. Thus, certain teaching styles may pose greater risk for the voice. Titze et al. (2007) suggested that the distribution of vocal rest periods is more important than total voice accumulation over the working day. Unfortunately, the minimum rest period for some recovery of vocal fold tissues is yet to be established (Bottalico, Pavese, Astolfi, Hunter, & Graetzer, 2014; I. R. Titze et al., 2007). It could be a few seconds - due to blood circulation (Švec & Sram, 2001) or internal tissue fluid (Fisher, Telsler, Phillips, & Yeates, 2001a), or several days – due to the response of epithelial cells or of the extracellular matrix of the vocal folds (Gray, Titze, & Lusk, 1987; I. R. Titze et al., 2007). Bottalico and colleagues (Bottalico, Graetzer, Astolfi, & Hunter, 2016; Bottalico, Pavese, Astolfi, Hunter, et al., 2014; Bottalico, Pavese, Astolfi, & Hunter, 2014) recently reported that teachers with vocal nodules tended to have lower silence accumulations of ≥ 3.16 s [indicating inadequate fluid redistribution in the vocal fold tissue (Fisher et al., 2001), as noted by Bottalico et al (2016)]. Longer silence periods are important to ensure short term vocal recovery (Bottalico et al., 2016). Increased vocal load and vocal misuse may also contribute to changes in external laryngeal muscle function (e.g. muscle tension and constriction/dysregulated muscle function), leading to hyperfunctional problems (Aronson & Bless, 2009; Colton et al., 2011; Vilkman, 2004).

In the last three decades, studies have been carried out in the teaching environment in order to quantify vocal load, using different designs and instruments such as head microphones connected to an audio-recorder, or accelerometers (sensors used for measuring accelerations of vocal fold vibration) such as voice accumulators or voice dosimeters. Voice samples, audio-recorded during the teacher's working day, have been analyzed to investigate changes in vocal quality, fundamental frequency (F0) and sound pressure level (SPL) (Rantala et al., 1998; Södersten, Granqvist, Hammarberg, & Szabo, 2002). Voice dosimeters allow the measurement of vocal dose on the job, at home or elsewhere across all waking hours of the day. Voice dosimeters have been developed for monitoring voice use at work based on measurements of skin vibration on the neck (Cheyne,

Hanson, Genereux, Stevens, & Hillman, 2003; Hillman, Heaton, Masaki, Zeitels, & Cheyne, 2006; Popolo, Svec, & Titze, 2005; Švec, Popolo, & Titze, 2003; Szabo, Hammarberg, Håkansson, & Södersten, 2001; I. R. Titze, Švec, & Popolo, 2003). Early voice accumulators measured voicing time (i.e. vibration time of vocal folds), or the combination of voicing time and fundamental frequency, or voicing time and intensity for a period of up to 12 hours. These early devices have never been commercialized, however.

Recently vocal dosimeters have been developed for measuring fundamental frequency (F0), voice intensity (dB SPL), phonation time (seconds or %), vocal doses (cycle and distance dose), and background noise (when the speaker is not voicing) (APM; KayPENTAX, Lincoln Park, NJ), NCVS (National Center for Voice and Speech) voice dosimeter (Salt Lake City, UT), VoxLog (Sonvox AB, Umeå, Sweden), and VocaLog (Griffin Laboratories, Temecula, CA). An ongoing study has been testing a new low-cost smartphone-based device that allows additional measures based on estimates of subglottal airflow extracted from the accelerometer signal (Mehta, Zaňartu, Feng, Cheyne, & Hillman, 2012). At the time when the current research program was designed, the KayPentax Ambulatory Phonation Monitor (APM, Lincoln Park, NJ, USA) was the only commercialized voice dosimeter.

Several studies have investigated vocal load in the teaching environment using voice dosimetry (Åhlander et al., 2014; Gaskill, O'Brien, & Tinter, 2012; Hunter & Titze, 2010; Morrow & Connor, 2011; Portela, Hammarberg, & Södersten, 2013; Remacle et al., 2014). These have examined differences in vocal loading between teaching levels, occupational and non-occupational times of the day, across different teaching and other activities, and with and without voice amplification. Voice dosimetry studies have shown that teachers have higher phonation time during occupational than non-occupational time periods (approximately double the time), and phonate more than other professionals and the general population (Hunter & Titze, 2010; Masuda, Ikeda, Manako, & Komiyama, 1993; Sala et al., 2002; I. R. Titze et al., 2007). Furthermore, kindergarten and music teachers have been

found to have higher vocal load than elementary and classroom teachers, respectively (Morrow & Connor, 2011; Remacle et al., 2014).

Whether there is difference in vocal load in teachers with and without voice problems is still unclear. At the time when the current research program was designed, there was no long-term monitoring study involving teachers with voice problems. In a recent publication, however, Åhlander et al. (2014) analyzed teachers with and without self-reported voice problems and found higher phonation times for teachers with voice problems. A few studies involving a variety of occupational voice use groups have recently appeared in the literature. Vocal load and these related studies are discussed in detail for study 3 (included in this thesis as Chapter 4).

Purpose and rationale for the present research

This thesis identifies prevalence and risk factors for voice problems in teachers and differences in vocal load and teaching environment in teachers with and without voice problems.

International data suggests that voice problems are an important health risk for teachers and may have psychological, social, or economic consequences for teachers themselves and for the educational system and students' learning. Teachers rely on their voice as a primary work tool. Understanding vocal disorders in NZ teachers, through studying prevalence, risks and potential causal factors, the impact of voice problems on teachers' health, teachers' vocal loading and its effects on voice production will provide essential information for developing effective programs for prevention and treatment within the NZ context.

At the time this thesis was planned, there were few studies of teachers' vocal load using long-term monitoring of voice use and no studies had compared the vocal load of teachers with and without voice problems. This is an important topic in the occupational voice health area as the relationship between vocal load and voice problems in teachers is still unclear.

Prior to this research there were no available data on the prevalence of voice problems in NZ teachers. The teaching environment and teaching approaches differ across countries, thus prevalence and risk factors may also differ. Few studies have analyzed demographic variables and the nature of voice problems in teachers across an entire country. This was the focus of the first study presented in Chapter 2. Further, few studies have simultaneously investigated a wide range of factors associated with voice problems including demographics, voice-related aspects such as voice training and vocal load, teaching-related factors such as number of students and teaching level, environmental factors, and psychosocial factors through multivariate analysis. This was the focus of the second study presented in Chapter 3. Existing research has focused on demographic factors and voice-related symptoms, rather than loading-related physiological changes in voice production under field conditions. There is a need for field studies that simultaneously assess vocal load and the teaching environment in teachers with voice problems using objective measures. This was the focus of study 3 presented in Chapter 4. Epidemiological research methods (i.e. self-report questionnaires) were used to determine prevalence and variables associated with vocal problems in teachers in studies 1 and 2. Voice dosimetry and objective measures of the teaching environment were used in study 3.

Thesis structure and overview

This thesis has been structured in accordance with The University of Auckland guidelines for theses with publication, in which the core of thesis comprise published or unpublished research papers, with introductory and concluding discussion chapters. The core of the thesis comprises three research papers (corresponding to three different studies), along with an introductory chapter (Chapter 1), providing a contextual framework, and a concluding discussion (Chapter 5). Relevant literature is discussed in the introductory sections of chapters 2, 3, and 4. Three studies have been conducted and are presented as Chapters 2, 3 and 4, respectively.

The studies outlined in this thesis commenced with a 'big picture' large epidemiological study, obtaining crucial statistics on the prevalence of voice problems for teachers in NZ followed by two investigations that examine more closely risk factors for voice problems (study 2) and vocal load and environmental factors in field conditions (study 3).

The first study used a cross-sectional epidemiological design to estimate the prevalence and nature of voice problems in NZ teachers. This study involved close to 2000 primary and secondary teachers throughout the country. Teachers answered an online questionnaire with topics related to socio-demographic characteristics (gender, age, ethnicity, work location), work-related features (teacher level, school type), the nature of any vocal problems (severity, recovery, days-off), voice symptoms, health consultations, and presence of a vocal problem at different time periods (teaching career, teaching year, day of survey) in order to determine the prevalence rates of voice problems in NZ teachers.

The second study (Chapter 3) used multivariate analyses to identify factors associated with voice-related quality of life and voice problems in teachers. This study explored a wide range of potential associated antecedent factors and seven different voice-outcomes. Approximately 700 teachers from the first study participated in this second study, responding to a second questionnaire involving topics related to patterns of vocal use, acoustic and air quality features of the teaching environment, and psychosocial factors. Self-assessments in previous studies have focused on voice impairment, and have only looked in a limited way at the broader effects of voice difficulties on participation and activities. The questionnaire used in study 2 was developed based on a framework proposed by the World Health Organisation (WHO, 2001) and examined voice functioning and disability, the impact of voice problems on teachers' activities and life situations, and environmental and personal factors. Standardised measures were used to assess the impact of voice impairment on activity limitation and participation restriction, as well as the role of associated factors including psychosocial status and reflux symptoms.

Chapter 4 (study 3) describes an investigation in field conditions at the teachers' schools. This was a case-control study that investigated whether there are differences in

vocal load, teaching acoustic environment, and voice changes over the day, between primary and secondary teachers with and without voice problems. Thirty teachers, half with self-reported voice problems and half who were controls with healthy voices, were monitored for two typical teaching days using a vocal dosimeter (APM 3200; KayPENTAX, Lincoln Park, NJ) (Cheyne et al., 2003; Hillman et al., 2006) and a noise dosimeter (CEL-350 dBadge; Casella CEL Inc., Buffalo, NY). For both groups, laryngeal and voice assessments were performed using physiological, perceptual, and acoustic analyses, and a vocal self-assessment. Continuous measures during the teaching day were obtained using the APM voice dosimeter and noise dosimeter (Figure 1), to measure vocal load and ambient noise levels respectively. This is the first NZ study using the APM, allowing more specific conclusions about the effects of vocal load in teachers at work within the NZ context. Further measures including physiological laryngeal, room acoustics, voice recording, and subjective assessments of voice were conducted.



Figure 1. A person wearing the APM (ambulatory phonation monitor) attached to the neck and a noise dosimeter positioned on the shoulder.

Research Aims

This doctoral thesis aims to: a) determine prevalence and nature of voice problems in NZ teachers (Study 1); b) investigate factors associated with voice problems and voice related quality of life in teachers, including a wide range of personal and work-related factors (Study 2); c) investigate whether there are differences in vocal load and environmental noise levels and acoustic parameters of classrooms between primary and secondary teachers with and without self-reported voice problems; d) investigate changes in voice use over the teaching day for voice problem and control groups and both teaching levels; and e) determine correlations between vocal load parameters and voice self-assessment and environmental measures (Study 3). The combination of epidemiological, empirical and field studies in the present research was designed to better establish the association between voice disorders in teachers and potential antecedent factors.

Chapter 2: Voice problems in New Zealand teachers: A national survey

This chapter includes content from the article “**Voice problems in New Zealand teachers: A national survey**” published in the Journal of Voice, 2015, doi:10.1016/j.jvoice.2014.11.004

Introduction

Several occupations require effective oral communication, and the voice is pivotal to this. Amongst professional/occupational voice users, school teachers are one of the largest groups that depend greatly on their voice for work (Fritzell, 1996; I. R. Titze, Lemke, & Montequin, 1997; Verdolini & Ramig, 2001). For teachers, the voice is the main tool for transmission of information to pupils, therefore it is important that the voice is flexible, resilient, and clear for efficient teaching and learning. Vocal problems can have a significant impact on school teachers' work capacity, leading to important financial, educational and vocational costs to the community, employers and individual teachers and their families (Pemberton, Oates, & Russell, 2008; Roy, Merrill, Thibeault, Gray, et al., 2004).

There is international evidence that teachers are at higher risk of developing a vocal problem than other occupations, and the general population (M. Angelillo, Di Maio, Costa, Angelillo, & Barillari, 2009; Behlau et al., 2012; De Jong et al., 2006; Mattiske et al., 1998; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 2005; Sala, Laine, Simberg, Pentti, & Suonpää, 2001; Sliwiska-Kowalska et al., 2006; Van Houtte, Claeys, et al., 2011). Possible variables associated with this risk are gender, age, voice symptoms, voice use behaviors, family history of vocal problems, respiratory disease/allergies, depression/stress, and lifestyle (Medeiros et al., 2008; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell, 1999; Russell et al., 1998). Other occupational-related factors such as vocal loading, background noise, air quality, teaching subjects, and length of time in the profession may also be associated with the risk of developing a vocal problem (Thibeault et al., 2004; Vilkmán, 2004). In New Zealand (NZ), educational standards (NZ Ministry of Education, 2007) require a large amount of teacher-student interaction (both for group instruction and one-on-one interactions). There is a strong emphasis on catering for the needs of individual students and some teaching levels do not have teaching assistants, which may increase vocal loading compared to more traditional teaching approaches; this may contribute to the risk of voice problems.

Epidemiological studies are important for evaluating the relationship between exposure and disease prevalence in a defined population at a point in time (Porta, Greenland, & Last, 2008). Such studies are, in turn, valuable for public health planning purposes and for etiologic research. The reported prevalence of voice problems in teachers varies widely. Two reviews (Cutiva, Vogel, & Burdorf, 2013; Mattiske et al., 1998) on the occurrence of vocal problems in teachers have cited a range from 4% to 90% (Behlau et al., 2012; Medeiros et al., 2008; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998; Sala et al., 2001; Sapir, Keidar, & Mathers-Schmidt, 1993a; Sliwinska-Kowalska et al., 2006; Smith et al., 1997; Van Houtte, Claeys, et al., 2011). This variability in prevalence rates reflects differences in research methodology such as variation in definitions and measurement of vocal dysfunction, time frames for participants' reporting of vocal problems, and participant inclusion and exclusion criteria. Among studies using self-reported vocal symptoms as the voice outcome measure, prevalence rates range from 20% to 59% (Alvear, Barón, & Martínez-Arquero, 2010; Medeiros et al., 2008; Smith, Lemke, et al., 1998). Prevalence varies between 37% and 69% when a voice disorder is indicated by the presence of laryngeal pathology (Preciado-López, Pérez-Fernández, Calzada-Uriondo, & Preciado-Ruiz, 2008; Sala et al., 2001; Sliwinska-Kowalska et al., 2006). When a vocal problem is defined not only by the presence of voice symptoms but also by the impact of those symptoms on the teacher's life, prevalence rates are more consistent across studies. Studies using similar methodology (self-report surveys with similar definitions of a vocal problem) conducted in Australia, USA, and Brazil show prevalence rates of 11-16% on the day of the survey (Behlau et al., 2012; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998). Prevalence during the teaching career is reported as 19% (Russell et al., 1998) and, across the life time, 58%-63% (Behlau et al., 2012; Roy, Merrill, Thibeault, Gray, et al., 2004). Table 1 summarises previous studies that used self-report questionnaires to estimate the prevalence of voice problems in teachers (Alvear, Barón, et al., 2010; Behlau et al., 2012; De Jong et al., 2006; Medeiros et al., 2008; Munier & Kinsella, 2008; Roy, Merrill,

Thibeault, Parsa, et al., 2004; Russell et al., 1998; Sapir et al., 1993a; Smith, Lemke, et al., 1998; Van Houtte, Claeys, et al., 2011).

Although teachers' voices have been widely studied, epidemiological studies in different countries are essential to plan context-specific prevention and treatment programs. Teaching environment and approaches, and cultural and socioeconomic aspects differ across countries, thus prevalence and risk factors may differ. There are no previous studies of NZ teachers' voices so the true prevalence, nature, and the extent of voice problems in NZ teachers are unknown. NZ is a small country with a population of approximately 4.2 million (Statistics New Zealand, 2006). Teachers represent 3.9% of the work force in NZ (Statistics New Zealand, 2006). Most children attend public schools with class sizes of approximately 25 students.

The current study aimed to contribute to the future development of effective preventive and educational programs for voice problems in the NZ context, and to the voice literature by providing further data on the extent and nature of voice disorders internationally. The study used an epidemiological cross-sectional survey method to determine the prevalence of voice problems in NZ teachers and investigate possible associations between those prevalence rates and the demographic characteristics of the sample. The study also characterized voice problems according to aspects such as severity, recovery time, voice symptoms, days away from work and health consultations and examined associations with demographic variables and experience of voice education and training. Few previous studies have characterised teachers' voice problems in this comprehensive way.

Methods

Participants

Research participants were primary and secondary teachers who were members of the two largest education unions in NZ (primary and secondary unions). In total, there are approximately 63,000 members in those unions, including not only teachers but other school staff. It is estimated that in NZ, there are approximately 36,000 primary and secondary

teachers in state government schools (Education Counts, 2011). An email with the research invitation and web link for the questionnaire was sent by a union staff member to their representatives in each primary and secondary school throughout the country, including urban and rural areas. Participant recruitment processes were designed to facilitate equitable access to the research for teachers across the country. Union representatives were instructed to forward the email to all teachers who were union members. The unions estimated that 18,440 members had the potential to receive the email or a newsletter with the web link, however because not all teachers open emails, the number accessing the web link is likely to be significantly lower and it is not possible to determine response rate accurately. Based on the unions' previous survey and email opening response rates, it is estimated that approximately 25% to 30% of potential participants accessed the survey. Unions contacted members via web-based technology. Every NZ school has computer access for teachers, however most teachers have their own computer in the classroom.

In order to obtain the best estimate of prevalence rates and to minimise self-selection bias towards teachers with voice problems, the study invitation was designed to be as neutral as possible. The information provided invited teachers to participate in a 'voice use study' and did not mention 'voice problems/difficulties' (e.g. 'voice problems in teachers' or any question such as 'have you lost your voice?').

Online questionnaire

The self-report questionnaire was designed using the professional version of SurveyMonkey® software (Palo Alto, California, USA) to investigate the prevalence and the nature of voice problems in teachers. The first question was related to the inclusion criterion; only teachers who indicated that they had been teaching over the previous 12 months were able to continue to answer the questionnaire and participate in the study. The online questionnaire covered socio-demographic characteristics (gender, age, ethnicity, geographic region of work), work-related characteristics (teacher level, teaching subjects, school type, class size, duration of teaching career, hours of teaching work per week, and use of voice

amplification), voice education and training, frequency and severity of vocal problems and symptoms, recovery times, days away from work due to voice difficulties, and consultations with health practitioners. Questions were developed on the basis of previous literature on voice problems in teachers, the authors' clinical experience, and information about the NZ teaching context provided by staff from the two education unions.

The questionnaire was designed to be completed within a maximum of 10 minutes in an effort to maximise the response rate and to reliably estimate prevalence rates. All rating scales used in the questionnaire were presented as Likert scales. In order to increase the response rate, the questionnaire was designed based on recommendations in the literature for web survey design (Cook, Heath, & Thompson, 2000; Edwards et al., 2002). These recommendations included the use of short, clear and logical questions, use of 'skip' questions, careful selection of the day on which the questionnaire was sent to teachers (i.e., the beginning rather than the end of week), and delivery of reminder emails at two-weekly intervals. Teachers had the option of being anonymous or providing their email address for future phases of the study. The online version was tested with 9 primary and secondary teachers and 5 non-teachers, recruited via the first author's personal contacts, to test for technical, wording, and configuration issues. The questionnaire was sent to teachers during October-December 2010 and February-May 2011.

Voice problem measures

Prevalence rates were estimated for three time frames: career, year and point prevalence. Career prevalence was defined as the frequency of voice problems during the individual's entire teaching career, year prevalence as the frequency of voice problems during the 2010 teaching year, and point-prevalence as the presence of a self-reported voice problem on the day of the survey. The three time points were chosen to provide more comprehensive data about the history, chronicity and variation over time in teachers' experience of voice problems while teaching. These time-frames were used by Russell et al. (1998) and were adopted for the current survey to enable direct comparison between the

studies. Eight items from Russell's questionnaire (1999) covering the frequency and severity of voice problems, recovery times, and days away from work were used for the current study with her permission.

The following description of a voice problem included in the questionnaire was adapted from Russell et al. (1998) and Roy et al. (2004): '*A vocal problem can occur at any time. When there is a vocal problem, your voice changes or does not work as you expect, preventing you from using your voice in a satisfactory way. It may sound hoarse, raspy, creaky, breathy, weak, too high, too low, too soft, or may disappear entirely*'. This description of a voice problem was included in the questionnaire prior to voice-related questions. The latter were designed to prompt teachers to consider not solely vocal impairment but also the potential impact on their everyday life, that is, to encompass the activity and participation components of ICF framework (WHO, 2001). The voice-related questions for each time point were as follows:

- Career prevalence - *During your teaching career, how often have you had a problem with your voice which prevented you from doing all you wanted to with it?* Response options were: *never, rarely, once every 2-3 years, once a year, twice a year, several times per year (between 3 and 11 times per year), monthly or more frequently (e.g. fortnightly, weekly)*. Teachers were categorised as having a vocal problem during their teaching career if they experienced a problem twice a year or more frequently.
- Year prevalence - *During the 2010 teaching year, how often did you have a problem with your voice which prevented you from doing all you wanted to with it?* Response options were: *never, once in 9 months, once every couple of months, monthly, fortnightly, weekly, daily*. Teachers were considered as having a vocal problem during the teaching year if they experienced a problem every couple of months or more often.
- Point prevalence - *Do you have a vocal problem today?* Response options were: *yes or no*.

For the year prevalence time frame, teachers who reported a voice problem at any frequency answered further questions about recovery time (*'less than one day'* through to *'my voice has not returned to normal'*), severity (*'very mild'* to *'very severe'*), days away from work (from *'zero'* to *'more than six days'*), and consultations with health professionals (*'yes'* or *'no'*, and number of visits). For point prevalence, teachers reported only the presence of a vocal problem and its severity. These additional questions were not included for career prevalence. Finally, all participants answered questions regarding vocal symptoms (see Figure 4), regardless of whether or not they reported a vocal problem. Symptoms were rated according to frequency (*'never'* to *'every time I use my voice'*) and severity (*'very mild'* to *'very severe'*): alteration of voice quality (e.g. hoarseness, roughness, huskiness, strained voice, weak voice), vocal effort (e.g. effort or force needed to speak), vocal fatigue (e.g. tired voice), complete loss of voice (e.g. voice disappears completely), alteration of voice pitch (e.g. different pitch than usual such as pitch too high, too low, smaller pitch range, uncontrolled pitch), alterations of voice loudness/volume (e.g. too soft, loud, uncontrolled loudness, difficulty making the voice as loud or as soft as needed), voice breaks or cracks during speaking, difficulty projecting my voice, throat discomfort (e.g. throat pain, dryness, burning, tightness, cough/clearing throat), breathing difficulties (e.g. shortness of breath or running out of breath while speaking, noisy breathing), and singing difficulties (e.g. difficulty reaching high notes, voice breaks during singing).

Statistical Analysis

IBM SPSS Statistics v.21 software (Armonk, NY) was used for statistical analysis. Firstly, the data were screened for errors, outliers and missing data. Descriptive statistics were calculated for the voice problem measures at each of the three time periods. A chi-square test was used to compare categorical variables (gender, age band, teacher level) for teachers with and without reported vocal problems based on the three prevalence time frames. For teachers with reported vocal problems during the year, chi-square tests were used to examine severity, recovery, consultations with a health professional, and days away

from work. Response categories were collapsed for chi-square analysis of severity, recovery time, and days away from work due to a low number of cases in some cells. Three separate logistic regression models were fitted to the data to examine possible links between demographic factors and voice problems (for career, year, and point prevalence). For each logistic regression analysis there was one dichotomous outcome (voice problems) and three independent variables (gender, age, teaching level). The confidence interval adopted was 95% ($p < .05$). Cronbach's alpha coefficients were calculated to determine the reliability of frequency and severity of symptoms scales. Due to the ordinal nature of the symptoms scales, nonparametric Mann-Whitney U tests were used to analyze differences in symptoms between males and females, between age bands, and for teachers with and without voice problems based on the year time frame. Using the R statistical package *bestglm* (Best Subset GLM) (McLeod & Xu, 2011; Xu, 2010), a logistic regression model and the Akaike Information Criterion (AIC) were used to select the best model for identifying key voice symptoms associated with a self-reported voice problem. Teachers were asked about symptoms during the teaching year and hence year prevalence was the dependent variable in this analysis. All teachers, with and without reported voice problems, were included in the model.

The study was approved by the Human Participants Ethics Committee of The University of Auckland (2010/459).

Results

Of the 18,440 eligible teachers to receive the study invitation by email, 2,338 teachers accessed the survey. Four hundred and fifty-nine subjects were excluded as they reported working as a school teacher for less than 12 months, being a principal without any teaching work, or being teachers of distance learning (correspondence school), adult learners, or early childhood, or due to incomplete responses (missing responses for prevalence of voice problems questions). Thus, 1,879 teachers were included in the study. The final sample was composed of 1,363 women (72.5%) and 516 men (27.5%); 474 (25%)

primary teachers and 1,414 (75%) secondary teachers. Complete group characteristics for categorical variables are portrayed in Table 2. Primary teachers were classified as those teaching years 1 to 6, and secondary teachers were defined as those teaching specialist subjects at or above year 7. The average age of all participants was 46.4 years (SD 11.9 years, range 21-77); for women was 45.6 years (SD 11.8 years, range 21-74 years) for and for men 48.71 (SD 11.6, range 24-77). The average duration of teaching work experience was 16.8 years (SD 11.7 years, range 1-52 years). The average number of working hours per week as a teacher was 47.63. This number exceeds the usual 37.5 or 40 hour working week because respondents included extra unpaid work hours (including, for example, preparation time, marking, meetings and training). Class size was 24.93 students on average. A breakdown of teaching subjects is shown in Appendices.

The gender and age distribution in the sample was representative of the NZ teaching population based on Ministry of Education data (Education Counts, 2011). Ethnicity categories were presented at level 1 (broadest categories) according to Statistics NZ standards (Statistics New Zealand, 2009). In NZ, there were approximately 37,000 school teachers at the time of the survey, 24% males and 76% females; 74% are NZ European/European, (12%) are Māori/Pacific, 3.5% are Asian, and 3.5% are other ethnicities. The NZ Ministry of Education data indicate an even spread across the 30s, 40s and 50s age bands, whereas the current sample has more teachers in the older bands. Teachers from all NZ regions completed the survey. The number of male primary teachers is small (n=54, 10.2%), however this is similar to the gender balance amongst primary teachers reported by Ministry of Education for NZ teachers (8.8%) (Education Counts, 2011).

Prevalence rates

Three prevalence rates were estimated in the current study. The prevalence of vocal problems reported by teachers during their teaching career (career prevalence) was 33.2% (CI: 31.1-35.4%), during the teaching year (year prevalence) was 24.7% (CI: 22.8-26.7%), and on the day of survey (point prevalence) was 13.2% (CI: 11.7-14.8%).

There were significant differences in prevalence between genders for the three prevalence time frames (Figure 2). Female teachers reported more voice problems than males during their teaching career (35.7% vs 26.6%; $\chi^2(1)=14.22$, $P<.001$), during the year (27.1% vs 18.4%; $\chi^2(1) =15.10$, $p<.001$), and on the day of survey (15.1% vs 8.1%; $\chi^2(1) =15.93$, $p<.001$). However, only point prevalence showed a significant difference across age bands ($\chi^2(4)=12.16$, $P=.016$) and teacher level ($\chi^2(2)=12.16$, $p=.016$). The highest frequency of self-reported voice problems was found for teachers aged 50-59 years, followed by 60+, 0-49, 20-29, 30-39 age bands, and for primary teachers. There was no significant difference across working locations, however, there was a trend ($\chi^2(2)= 4.696$, $p=.096$) for higher levels of reported voice problems (during teaching career) for teachers who work in semi-rural/rural areas (38.2%), followed by large cities (33.6%), and small towns (29.4%).

Gender, age, and teacher level were included in a logistic regression model to determine the association between these variables and voice problems. Table 3 portrays the odds ratio values according to gender, age, and teacher level determined by the logistic regression models for the three prevalence outcome measures (career, year and point prevalence). The analysis showed that gender, age, and teaching level influenced voice outcomes when considering point prevalence; odds ratios indicate that female teachers (OR=1.86, CI: 1.29-2.67), those aged 50-59 years (OR=1.84, CI: 1.12-3.03), and primary teachers (OR=1.79, CI 1.33-2.40) were more likely to report voice problems. For year prevalence, significance was found for gender only; women were more likely to have voice problems (OR=1.68, CI: 1.28-2.16). For career prevalence, teachers aged 30-39 (OR=0.68, CI: 0.48-0.98) and 60+ (OR=0.67, CI: 0.45-1.00, note P value was .050) were less likely to report voice problems than the youngest teachers (20-29 years old); and women were also significantly more likely to report voice problems than men (OR=1.48, CI: 1.17-1.87).

Severity, recovery time and days away from work

Of 1,081 teachers who reported any voice problem during the teaching year, 52.5% reported very mild/mild voice problems, 36.5% moderate, and 10.9% severe/very severe. In terms of recovery time, 70.5% answered that their voice took less than one week to recover, 22.5% took 1-4 weeks, and 7% reported chronic voice problems (longer than 4 weeks recovery time). For 2.9% of those with chronic problems, their voice had not recovered. Even though teachers reported a vocal problem with some limitation (i.e. a problem with their voice that prevented them from doing all they want to with it), 63.8% had not taken any days away from work, 27.8% were away for 1 to 3 days, 6.7% between 4-7 days, and 1.7% for more than 7 days. There was a significant association between severity and recovery time ($\chi^2(4)= 152.850, p<.001$), severity and days away ($\chi^2(4)= 155.165, p<.001$), and recovery time and absence days ($\chi^2(4)= 96.568, p<.001$). The relationship between severity of voice problems and recovery time occurred in the expected direction; teachers with more severe voice problems took longer to recover and had more days away from work (see Figure 3).

There were no significant differences between women and men in the severity of self-reported voice problems. However, women had relatively longer recovery times than men (68.1% <1 week, 25% 1 to 4 weeks, 7.5% >4 weeks vs 78.9% < 1 week, 16% 1 to 4 weeks, 5.4% \geq 4 weeks for women and men, respectively) ($\chi^2(2)=10.373, p=.005$). Women also had more days away from work due to a voice problem ($\chi^2(2)=31.615, p<.001$). More men (79) than women (60%) kept working even though they experienced a problem with their voice that had some impact on their daily life. Teachers aged 50 years or older were more likely to report chronic voice problems (>4 weeks of recovery time) than younger teachers ($\chi^2(4)=39.056, p<.001$). In general, primary teachers had slightly longer recovery time ($\chi^2(2)=7.552, p=.023$) and more days away from work than secondary ($\chi^2(2)=23.719, p<.001$) which could reflect the higher proportion of females in the primary teachers group.

General health and specialist support

Among all teachers who reported any frequency of voice problems during the year ($n=1,081$), about a quarter (22.4%) sought health assistance. These teachers mainly visited a general practitioner (GP) (97.5%), but a small percentage saw an otolaryngologist (ORL) (12.8%), a speech language pathologist (SLP) (2.9%), or other health professionals (3.2%). The proportion of women who sought health support was significantly higher than for men (25.1% vs 12.8%; $\chi^2(1)=16.459$, $p<.001$). Also, more primary than secondary teachers sought help (29.4% vs 19.9%; $\chi^2(1)=10.917$, $p=.001$). There was no statistical difference among age bands. Teachers with longer duration of recovery (≥ 1 week) sought health assistance more than those who experienced shorter recovery (<1 week (13.3%), 1-4 weeks (42.8%), >4 weeks (48.7%)) ($\chi^2(2)=125.092$, $p<.001$).

Teachers with chronic voice problems (longer than 4 weeks recovery time) presented a higher occurrence of moderate and severe problems ($\chi^2(2)=37.182$, $p<.001$), were more likely to stay away from work for more than 3 days ($\chi^2(2)=11.145$, $p=.004$), and to seek health support ($\chi^2(1)=32.537$, $p<.001$). Considering only teachers with chronic voice problems ($n=76$), less than a half (48.7%) consulted a health professional. Of the teachers who sought help, 91.9% visited a GP, only 37.8% were seen by ORL, and 16.2% by a SLP.

Voice symptoms

The severity and frequency of 11 voice symptoms were evaluated using two Likert scales (Figure 4). These questions were addressed to all teachers, not only to those who reported voice problems. Cronbach's alpha coefficients were 0.89 and 0.92 for the frequency of voice symptoms and severity of vocal symptoms scales, respectively, indicating high internal consistency. In general, the most frequently reported symptoms (both males and females), in descending order, were throat discomfort, voice quality alterations, vocal fatigue, singing difficulties, and vocal effort. In terms of severity, teachers rated throat discomfort, voice quality alterations, singing difficulties, and vocal fatigue as more severe symptoms. There were significant differences in scores between males and females for frequency and

severity of voice symptoms. Overall, females reported more frequent ($U=393.6$, $p<.001$) and more severe ($U=288.9$, $p<.001$) symptoms; very few males rated the severity of their symptoms as 4 (severe) or 5 (very severe).

All symptoms showed statistical differences between teachers with and without self-reported voice problems over the year ($p<.001$). For all symptoms, ratings of severity and frequency were significantly correlated ($R_s=.59$ to $.70$, $p<.001$) (moderate to strong correlations). Both severity and frequency data showed significant group differences, however, the frequency of symptoms scale data indicated greater group differences based on the Mann Whitney U statistic. In order to determine key differences in self-reported symptomology between teachers with and without voice problems, frequency of symptoms data were further explored to identify the symptoms most often associated with a voice problem, and which occurred infrequently in teachers without voice problems. Four of the symptoms that were investigated (frequency of loudness alteration, complete voice loss, breathing difficulties, and singing difficulties) showed considerable overlap in the distribution of scores for teachers with and without voice problems and had the same mode, hence these symptoms were not effective in separating the groups. The mode and median frequency values for the remaining seven symptoms differed between the voice problem and non-voice-problem groups. The AIC logistic regression analysis produced a best fit model ($\chi^2(5)=677.27$, $p<.001$) that included five of these seven symptoms. Voice quality alteration (OR=4.35; CI: 3.40-5.57), vocal effort (OR=1.15; CI: 0.96-1.37), voice breaks (OR=1.55; CI: 1.30-1.84), voice projection difficulty (OR=1.25; CI: 1.04-1.50), and throat discomfort (OR=1.22; CI: 1.02-1.47) were the symptoms that showed a significant association with self-reported voice problems.

Voice education and vocal training, voice amplification

Most of the teachers (83.3%) had never attended any voice training or voice care program during their lifetime. Only 16.7% reported attending voice training (14.5%) or a voice care program (3.2%). Of those teachers who had previously received some training or

voice education, 52% undertook this before training as a teacher, 19.2% (3.2%) during teaching training, and 29.1% (4.8%) since qualifying as a teacher. Thus, only 9.5% of 1,879 teachers had received voice training during their teaching education or after qualifying as a teacher. Teachers who have had more than 10 hours of voice training/education were significantly less likely to report voice problems during the year (15.5% vs. 25.7%; $\chi^2(1)=9.423$, $p<.002$). Approximately 5% of teachers reported using some type of voice amplification during teaching, which includes sound field and/or portable amplification.

Discussion

The present study aimed to determine the prevalence and nature of voice problems in NZ teachers using a national self-report questionnaire. One third of NZ teachers reported experiencing voice problems at some point during their teaching career. Older female school teachers, aged 51-60 years, teaching primary level were more at risk of developing a voice problem. Approximately one third of teachers missed at least one day of work per year because of a problem with their voice. A very small proportion of the teachers had received voice training or treatment. Fewer hours of voice training/education were associated with higher reported voice problems. Teachers with chronic voice problems had typically not visited a specialist health professional.

To our knowledge this is the first epidemiological study using an online questionnaire to survey teachers across the whole country, including rural areas. Only one study has previously surveyed teachers from an entire country by personal interview and self-administered questionnaire, however recruitment from rural areas is not mentioned (Behlau et al., 2012). It may be, therefore, that the present results are more representative of the whole population than those from previous studies that sampled mainly city dwellers. Using an online questionnaire was the most viable and cost-effective way to reach teachers from all regions of the country. Importantly, the study invitation was written in neutral language to reduce the risk of self-selection bias toward teachers with voice problems. The final sample size was representative of the total population of primary and secondary teachers registered

on the New Zealand Ministry of Education database (Education Counts, 2011). This study is novel as it examines voice problems across a whole country including rural and city areas, teaching level is investigated in more detail than previously, and both symptom frequency and severity were explored.

Prevalence rates

The occurrence and impact of voice problems in NZ teachers was previously unknown. There are few voice clinics in the country and anecdotal reports indicate that few teachers are assessed or treated clinically, despite international evidence for high rates of voice problems amongst teachers and voice clinic visits by these professionals (Coyle, Weinrich, & Stemple, 2001; I. R. Titze et al., 1997). We questioned whether the prevalence of voice problems in NZ would be similar to other countries, especially in comparison with Australia, which has a similar education system, a large European population, and geographical proximity.

Similar to other countries, prevalence rates of vocal problems in NZ teachers are high. Prevalence rates reported in the literature differ widely, and it is difficult to make comparisons between studies due to differences in the definitions of voice problems as well as time frames and response formats on the surveys. Some studies have examined lifetime prevalence, which includes voice problems prior to the start of the teaching career (M. Angelillo et al., 2009; Behlau et al., 2012; De Jong et al., 2006; Roy, Merrill, Thibeault, Parsa, et al., 2004), whereas others have included the teaching career (Gotaas & Starr, 1993; Russell et al., 1998; Sapir et al., 1993a; Sliwinska-Kowalska et al., 2006; Van Houtte, Claeys, et al., 2011), year (De Jong et al., 2006; Russell et al., 1998), point (Alvear, Barón, et al., 2010; M. Angelillo et al., 2009; Behlau et al., 2012; De Jong et al., 2006; Munier & Kinsella, 2008; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998; Sapir et al., 1993a), or an unspecified time frame (Åhlander et al., 2011; Chong & Chan, 2010). Point prevalence estimates are most consistently defined, and thus are probably the best measure for making comparisons across studies. This is consistent with a recent systematic review

(Cutiva et al., 2013) which recommends adopting a well-defined recall period not longer than 12 months to avoid recall bias. Compared with studies using similar voice problem definitions and time-frames, the NZ point prevalence (13.2%) is similar to U.S. (11%) (Roy, Merrill, Thibeault, Parsa, et al., 2004), Brazilian (11.3%) (Behlau et al., 2012), and Australian (16%) (Russell et al., 1998) studies.

The present study used the same prevalence questions, time frame and definition of a voice problem used in a previous Australian study, conducted in the state of South Australia (Russell et al., 1998). NZ point and year prevalence rates are similar to the Australia data (point – NZ: 13.2% /AUS: 16%; year – NZ: 24.7% /AUS: 20%), however, NZ teachers reported more voice problems during their teaching career than Australians (NZ 33.2%, AUS 19%). As the prevalence questions were the same and the education system is comparable, the higher prevalence rate for teaching career in the NZ sample may be due to factors such as differences in the longevity of teaching careers, differences in the classroom environment, lack of awareness of voice care amongst teachers in NZ, or demographic differences between the NZ and AUS samples.

Gender

Findings from the current study indicate that female primary teachers aged over 50 years old were more likely to report voice problems. Epidemiological studies differ regarding the association between gender and voice problems in school teachers. Some authors have reported that voice problems are more common in female teachers (M. Angelillo et al., 2009; Chong & Chan, 2010; De Jong et al., 2006; Roy, Merrill, Thibeault, Parsa, et al., 2004), while others did not find significant gender differences (Munier & Kinsella, 2008; Preciado-López et al., 2008). The prevalence of voice problems was significantly higher in females compared to males for the three prevalence time-frames and these results are in accordance with the Australian data (Russell et al., 1998). It has also been observed that female teachers have more severe (Russell et al., 1998) and more chronic vocal problems (Roy, Merrill, Thibeault, Parsa, et al., 2004). It has been hypothesised that women present with more voice problems

due to physiological characteristics including shorter vocal folds and thus higher speaking fundamental frequency (Roy, Merrill, Thibeault, Parsa, et al., 2004) (vocal folds collide more times per second than men) (Vilkman, 2004) and less concentration of hyaluronic (HA) acid in the superficial layer of lamina propria and more concentrated in deeper layers (whereas men present a consistent distribution through the vocal folds) (Butler, Hammond, & Gray, 2001; Ward, Thibeault, & Gray, 2002). Reduced concentration of HA in female superficial lamina propria “suggests less available tissue-dampening (shock-absorbing) capacity to withstand the vibratory trauma of phonation and less effectiveness for tissue repair if the vocal fold is traumatized” (p. 911) (Ward et al., 2002). Hyaluronic acid is important for wound repair (Ward et al., 2002). This may also explain the finding that women took longer to recover from their voice problems than men (Roy, Merrill, Thibeault, Gray, et al., 2004). Thus, epidemiological and physiological evidence from other studies are consistent with the present finding that women reported more voice problems than men. Further research is required, however, to confirm whether or not these physiological factors account for reported gender differences in prevalence and recovery times between men and women.

Age

The relationship between age and voice disorders in teachers varies among studies (Roy, Merrill, Thibeault, Gray, et al., 2004; Russell et al., 1998). In the current study the regression analysis showed that a significantly higher proportion of teachers aged 50-59 years old reported voice problems compared to the other age bands, after adjusting for gender and teacher level. Similarly, Roy et al. (2004) reported higher percentages of voice problems for teachers aged 50 years old, although these authors reported a higher risk for those older than 40 years old. Russell et al. (1998) found that teachers in the 31-40 years and over 50 years age bands were more likely to report voice problems in their careers than teachers in the 21-30 year group. Curiously, in the present study, teachers older than 60 years old were less likely to report a voice problem during their career than the youngest teachers ($p=.050$). It is possible that teachers who have managed to teach for many years

and beyond the normal retirement age, may have been able to do so because of their robust voices and effective voice care strategies.

Our results have also shown that recovery time increases as age increases. Voice problems around the age of 50 in women could be associated with menopause. Menopause transition may cause changes in the larynx such as muscular and mucosal dystrophy and atrophy (Abitbol, Abitbol, & Abitbol, 1999; Caruso et al., 2000), oedema, and dryness (Schneider, van Trotsenburg, Hanke, Bigenzahn, & Huber, 2004), that can affect vocal function and acoustics characteristics of the voice (D'haeseleer, Depypere, Claeys, Van Borsel, & Van Lierde, 2009; Raj, Gupta, Chowdhury, & Chadha, 2010). These changes may increase the time required for healing after vocal injury as well as increasing the risk of voice problems in women over 50. However, this proposal remains tentative, particularly because the impact of sex hormones on the larynx remains controversial (Schneider et al., 2007).

Teaching level

Only a small number of epidemiological studies have investigated differences in voice problems between primary and secondary teachers. Results from the current study have shown that primary teachers are more likely to report voice problems than secondary teachers. The current NZ teaching curriculum for primary teachers calls for a significant amount of interaction with the students (NZ Ministry of Education, 2007) which may increase vocal loading. A further reason may be that younger children require more attention and interaction with the teacher which may also increase vocal loading and reduce time for voice rest over the teaching day. The present result is consistent with that of Angelillo et al. (2009) for maternal (early childhood) and elementary school teachers. Kooijman et al. (2006) did not find differences in voice complaints between primary and secondary teachers. De Jong et al. (2006) reported that secondary teachers were at slightly higher risk when compared to non-teacher controls with low vocal load. Class size could be associated with vocal loading and might account for some differences across studies, however, in the current study class sizes were comparable across teaching levels.

Severity, recovery time and days away from work

Teachers with more severe problems took longer for their voices to recover. Most of these teachers reported having about 1 to 7 days away from school per year because of their voice problem. Although year prevalence data for NZ is comparable to Russell's data, more Australian teachers stayed away from work (42.7%) (Russell et al., 1998) than did New Zealanders (36.2%). Those figures are higher than those for Brazil (22.5%) (Behlau et al., 2012) and the U.S.A. (18.3%) (Roy, Merrill, Thibeault, Parsa, et al., 2004). Days away from work are a significant cost to the education system in terms of lost teaching days and educational outcomes. Unexpected teacher absences have a negative impact on student achievement (Miller, Murnane, & Willett, 2008). The use of substitute teachers has been reported to have a negative effect on children's learning and achievement (Damle, 2009). Furthermore, teachers' dysphonic voices are associated with students' difficulties in processing spoken language; children performed better when listening to a normal voice (Morton & Watson, 2001). Rogerson and Dodd (2005) found similar results, with no difference between mild and severe dysphonic voices, suggesting that any voice alteration is detrimental to children's speech processing. In Victoria (AUS), the cost of a substitute teacher is \$250 per day (data from 2008) and the estimated cost of one day of sick leave per teacher due to a voice problem is about AUD \$17.6 million per year (Pemberton et al., 2008). In USA, the approximate annual cost of sick leave due to voice problems in teachers is USD \$638 million (INSERM Collective Expertise Centre, 2006). In NZ, the estimated cost of sick leave due to a vocal problem could vary from NZD \$4 million to \$27.5 million based on figures from the current study.

General health & specialist support

Even though approximately a quarter of surveyed teachers reported frequent voice problems that had some impact on their daily life, only 22% of these teachers sought health support regarding their problem. This percentage is considerably lower than Australian figures (36.5%). This rate would be even less if the entire sample of teachers was

considered, not only teachers with voice problems. It seems that teachers in NZ hesitate to seek health assistance for voice problems. Possible reasons could include: lack of awareness about their own problem such as the risk of chronicity and worsening of the problem; lack of awareness of available specialized services for voice counseling, assessment and management, and how to get those services; the difficulty of taking a time off from their busy schedules or family responsibilities; concern regarding the specialist's possible recommendations regarding reducing teaching hours or a change of occupation (Roy, Merrill, Thibeault, Parsa, et al., 2004); and the belief that voice problem is common in the teaching profession (Da Costa et al., 2012). Because dysphonia is not recognized as an occupational disease in many countries, it may be difficult for a teacher to have extended sick leave to recover from a voice problem.

The data suggest that most teachers consult a medical doctor only when the problem becomes severe and takes longer to recover. A remarkable result is that less than half of teachers with chronic problems (more than 4 weeks of duration) visited an ORL specialist and very few saw a SLP. Again, the awareness of teachers regarding potential adverse effects of chronic voice problems and the existence of a specialized assessment and treatment seems to be limited. Consistent with Van Houtte et al. (2011), the occurrence of health seeking support due to a vocal problem among women was higher than men; probably because women have higher occurrence and longer duration of voice problems than men. In general, women are more likely to report symptoms or chronic conditions (Corney, 1990) and visit health agencies more often than men (Corney, 1990; Green & Pope, 1999). Inadequate treatment of early voice symptoms is a risk for voice problems (Vilkman, 2004); an earlier visit to an appropriate specialist would reduce this risk.

In NZ, most people see a GP first and visit a specialist by referral. The lack of specialist referral suggests that NZ teachers are not aware of specialized health professionals for voice problems and/or GPs are not aware of the role of specialist otolaryngologists. It may also be that GPs lack education regarding the importance of early referral to an ORL specialist or SLP. Voice campaigns to raise awareness about potential

adverse effects of voice problems and the need for early assessment and management may increase rates of help-seeking. Early vocal screening at school could detect teachers at risk and the involvement of school SLPs in voice education programs would enhance the access to assessment and treatment (Da Costa et al., 2012).

Voice symptoms

Symptom frequency is more commonly reported in the literature than symptom severity. In the present study, frequency and severity of symptoms are highly correlated, however, frequency better differentiated teachers with and without voice problems. Similar frequent symptoms have been found by others, such as dry throat/throat cleaning, hoarseness, vocal fatigue/tired voice, singing difficulties (Åhlander et al., 2011; Munier & Kinsella, 2008; Smith, Lemke, et al., 1998; Yiu, 2002). The symptoms with the strongest statistical association with self-reported voice problems in the current study were voice quality alteration, vocal effort, voice breaks, difficulty with voice projection, and throat discomfort. Vocal fatigue (vocal tiredness) is commonly reported by teachers (Munier & Kinsella, 2008; Preciado-López et al., 2008; Simberg, Sala, Vehmas, & Laine, 2005; Smith, Lemke, et al., 1998; Yiu, 2002), however it was not a symptom in the best fit model resulting from the regression analysis; probably because teachers, irrespective of having a vocal problem, reported that symptom. Researchers have reported that physical symptoms such as throat discomfort, voice projection difficulty, vocal fatigue, and vocal effort have more effect on job-related activities than changes in voice quality alone (Behlau et al., 2012; Roy, Merrill, Gray, & Smith, 2005). Voice quality alteration was an important symptom for participants in the current study, in combination with four other symptoms that other researchers have also identified as occurring frequently in teachers with self-reported voice problems. For teachers, identification of key symptoms is an important step needed to guide prevention and treatment. These five symptoms could be used to screen for voice problems in teachers. Early recognition of symptoms by teachers and appropriate intervention may

reduce the occurrence of more chronic and severe voice problems. The specific influence of key symptoms on teaching work requires further investigation.

Voice education and vocal training

Although the voice is the primary tool for teaching work, most teachers did not receive any formal vocal education, either during teaching training or after qualifying as a teacher. For teachers who reported some training, this mainly happened before training as a teacher, and hence was probably singing or drama voice training, rather than training specifically designed for classroom teachers. The association between low hours of voice training/education and higher frequency of reported voice problems suggests that training can be effective in reducing voice problems. Studies have reported positive results of either voice care programs (indirect approaches) (Pasa, Oates, & Dacakis, 2007; Pemberton et al., 2010) or direct voice training on the prevention of voice problems (Bovo, Galceran, Petruccelli, & Hatzopoulos, 2007; Duffy & Hazlett, 2004). However, the combination of both voice approaches appears to be more effective (Ilomaki, Laukkanen, Leppanen, & Vilkmann, 2008). A high prevalence of voice symptoms (17%) has been reported among teacher students, highlighting an urgent need for preventive voice education in teacher education programs (Ohlsson, Andersson, Södersten, Simberg, & Barregård, 2012). Regarding the NZ context, to our knowledge there are no specialised voice training elements in teacher education or in postgraduate professional development programs. This is an area where expanded SLP/SLT work is needed in NZ.

Summary and conclusions

This research contributes to the voice literature by examining the nationwide prevalence of voice problems as well as providing the first prevalence data on voice problems in NZ teachers. Roy et al. (2004b) stated that one of the purposes of an epidemiological study is to verify the consistency of prevalence outcomes. The present study revealed similar results to Australia (Russell et al., 1998) (point and year prevalence) and

USA (Roy, Merrill, Thibeault, Parsa, et al., 2004) and Brazil (Behlau et al., 2012) (point prevalence). We found a high prevalence of voice problems in NZ teachers, consistent with that reported in other countries. Most NZ teachers with voice problems do not seek health support for their problem and seem not to be aware of the nature and potential consequences of voice problems, and what specialist support is available. Preventive and tailored treatment programmes for NZ teachers are clearly needed.

Females embarking on a teaching career can anticipate more voice problems than their male teaching colleagues and hence voice education is particularly vital for women entering the profession. Gender, age, and teaching level are associated with voice problems but these demographic characteristics cannot be changed. It is important to invest time determining other factors that can be addressed to reduce voice problems in teachers. Five key symptoms (voice quality alteration, vocal effort, voice breaks, difficulty with voice projection, and throat discomfort) are suggested for voice screening in teachers. As always for cross-sectional epidemiological studies, we are not able to infer causality because it is not possible to establish a time sequence, hence the next phase of this research will investigate potential factors contributing to voice problems in teachers in field conditions. It would be valuable to conduct a longitudinal study to observe changes in frequency and severity of voice problems and symptoms, recovery time, days off, visits to health professionals and potential associated factors, over a year or longer for teachers to determine the best way to manage these problems.

Table 1

Summary of Studies on Prevalence of Voice Problems in Teachers Using a Self-report Questionnaire for a Specified Time Frame

Location	Authors & Year	Sample Size & Participants	Instrument	Voice problem definition	Prevalence rates (%) (for teachers only)
USA (Texas, Washington, Chicago and Illinois)	Sapir et al. (1993)	237 teachers (kindergarten, elementary, and high school)	Self-administered questionnaire (paper)	Vocal attrition related symptoms (three or more symptoms)	Current symptoms (during or after teaching): 51% Career-linked symptoms: 33%
USA (Iowa)	Smith et al. (1998)	554 teachers (elementary and high school) & 220 non-teachers	Self-administered questionnaire (paper by mail)	Voice problem (no description) Voice symptoms (VS)	Lifetime voice problem: 32% One symptom (lifetime): 20.4% ≥2 symptoms (lifetime): 29.8%
Australia (South Australia state)	Russell et al. (1998)	877 teachers (preschool, primary, and secondary)	Self-administered questionnaire (paper by mail)	'A problem with your voice which prevented you from doing all you wanted to with it'	Point: 16% Year: 20% Career: 19%
USA (Utah & Iowa)	Roy et al. (2004)	1243 teachers (elementary and secondary) & 1288 non-teachers	Telephone interview	'Any time the voice does not work, perform, or sound as it normally should, so that it interferes with communication'	Point: 11% Lifetime: 57.7%
Netherlands	De Jong et al. (2006)	1878 teachers (primary and secondary) & 239 non-teachers	Self-administered questionnaire (paper)	Voice complaints	Point: P 17.4%/S 17.8% Past year: P 31.6% / S 35.8% Career: P 54.8%/S 59.2% During training: P 16.6%/S 12% P= Primary / S= Secondary
Ireland (Dublin city)	Munier & Kinsella (2008)	304 teachers (primary)	Self-administered questionnaire (paper)	No description	Point: 27% Intermittent: 53%
Brazil (Belo Horizonte city)	Medeiros et al. (2008)	2013 elementary female teachers	Self-administered questionnaire (paper)	Voice symptoms (tiredness to speak and any loss of voice quality)	Past two weeks Probable dysphonia: 15% Possible dysphonia: 52%
Italy (Naples district)	Angelillo et al (2009)	504 teachers (maternal, elementary, junior high, senior high) & 402 non-teachers	Self-administered questionnaire (paper)	No description	Point: 8.7% Lifetime: 51.4%
Spain (Malaga city district)	Bermudez et al. (2011)	282 (kindergarten and elementary)	Self-administered questionnaire (paper)	Vocal effort + minimum of two voice symptoms	Point: 59%
Belgium (provinces of Flanders)	Van Houtte et al. (2011)	994 teachers (kindergarten, elementary and secondary) & 290 non-teachers	Self-administered questionnaire (paper)	'Any time the voice did not work, perform, or sound as it usually does and interfered with communication'	Career: 51.2%

Brazil (27 states)	Behlau et al. (2012)	1651 teachers (elementary and secondary) & 1614 non-teachers	Face-to-face interview	'Any time the voice does not work, perform, or sound as it normally should, so that it interferes with communication'	Point: 11.6% Lifetime: 63%
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Table 2

Demographic Characteristics of Teachers According to Gender, Age groups, Teacher Level and Work Geographic Location

Variable	n	%
Gender		
Female	1365	72.6
Male	518	27.4
Age		
20 – 29	200	10.6
30 – 39	371	19.7
40 – 49	455	24.1
50 – 59	575	30.5
≥60	269	14.2
Ethnicity		
Pakehā / European	1620	85.8
Māori / Pacific Islander	187	9.9
Asian	60	3.2
Other	21	1.1
Teaching level		
Primary / Intermediate	474	25.1
Secondary	1414	74.9
Work geographic location		
Large city	1306	69.2
Small town	396	21.0
Rural / Semirural area	186	9.9

Note: Pakehā: NZ European / Māori: NZ native people. The 'Large city' group includes the five largest population cities in NZ: Auckland (Northern, North Island), Christchurch (North-Eastern, South Island), Wellington (Southern, North Island), Hamilton (Middle-Western, North Island) and Dunedin (Southern, South Island)

Table 3

Influence of Gender, Age and Teacher Level on Voice Problems (VP) Defined Based on Point, Year and Career Prevalence Time Frames

Variable	VP (point)		VP (year)		VP (career)	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Gender						
Male	1		1		1	
Female	1.85 (1.13 - 2.37)	.009	1.68 (1.28 - 2.16)	<.001	1.48 (1.17 - 1.87)	.001
Age						
20 - 29	1		1		1	
30 - 39	0.98 (0.56 - 1.73)	.961	0.86 (0.58 - 1.29)	.488	0.68 (0.48 - 0.98)	.041
40 - 49	1.10 (0.68 - 1.88)	.710	0.95 (0.65-1.40)	.814	0.74 (0.52 - 1.05)	.098
50 - 59	1.84 (1.11 - 3.00)	.010	1.13 (0.78 - 1.63)	.521	0.78 (0.56 - 1.09)	.156
60+	1.61 (0.91 - 2.86)	.100	1.04 (0.68 - 1.60)	.839	0.67 (0.46 - 1.00)	.050
Teacher level						
Primary/Intermediate	1.79 (1.33 - 2.40)	<.001	1.03 (0.81 - 1.32)	.786	1.07 (0.86 - 1.35)	.786
Secondary	1		1		1	

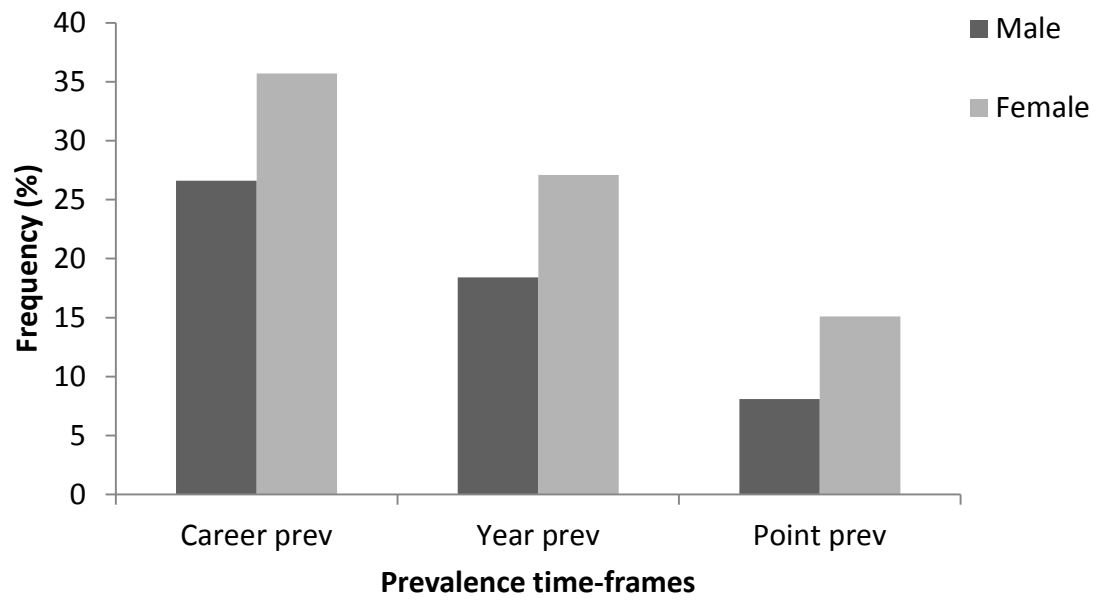


Figure 2. Prevalence rates of voice problems according gender.

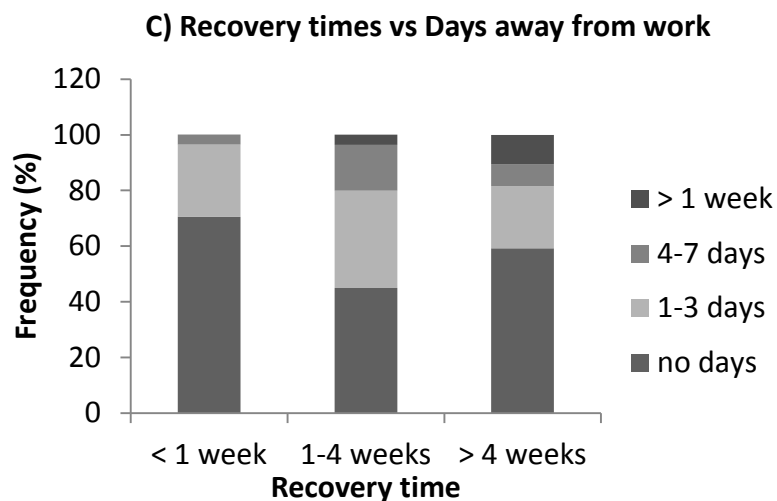
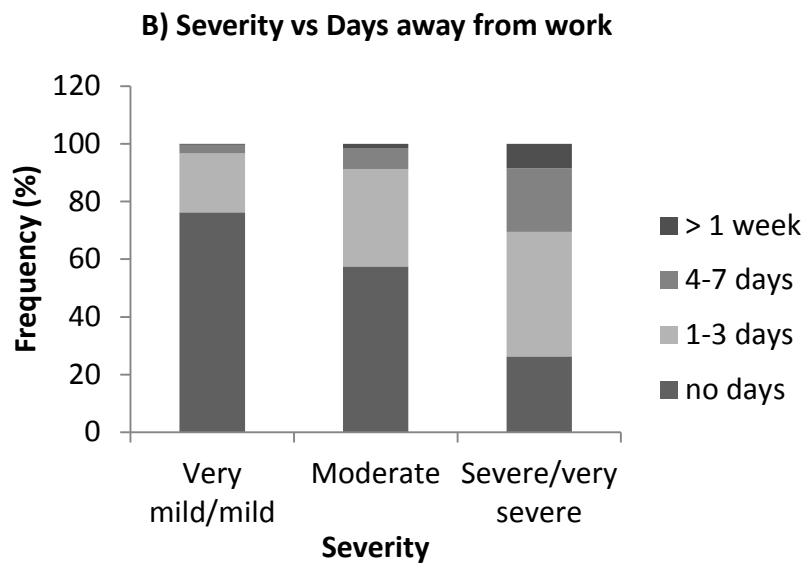
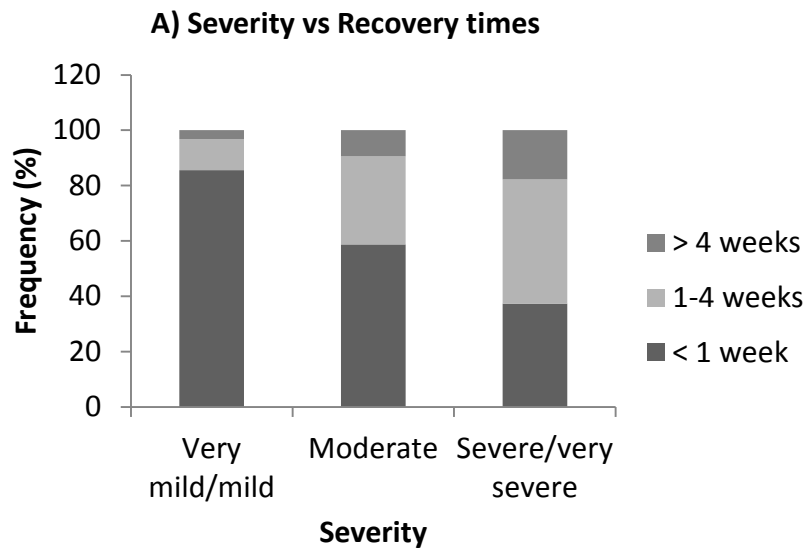
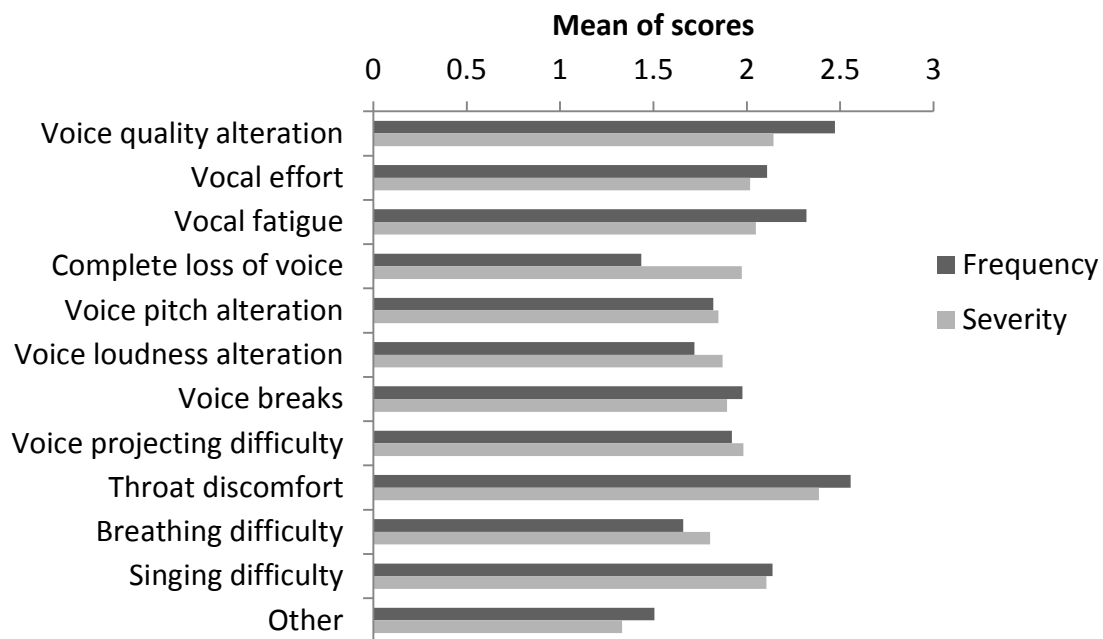


Figure 3. Frequencies during the year of A) recovery times (<1 week, 1-4 weeks, >4 weeks) for teachers reporting different severities of voice problems, B) days away from work for teachers reporting different severities of voice problems, and C) days away from work for different times.



(Frequency of voice symptoms scale: never=1, seldom=2, sometimes=3, often=4, every time I use my voice=5; Severity of voice symptoms scale: not applicable, very mild=1, mild=2, moderate=3, severe=4, very severe=5)

Figure 4. Frequency and severity of voice symptoms reported by teachers during the year.

Chapter 3: Factors associated with voice related quality of life and vocal problems in teachers

Introduction

Voice problems in teachers have been the focus of a large number of studies in the occupational voice use area. It is well documented that teachers are at greater risk of developing voice problems than the general population and other professional groups (Aronson & Bless, 2009; Behlau et al., 2012; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 2005; Russell et al., 1998; Sliwinska-Kowalska et al., 2006; Smith et al., 1997). It is estimated that 19 to 33% of teachers report frequent voice problems during their teaching career, around 20-25% during a year-interval (Charn & Mok, 2012; Leão, Oates, Purdy, Scott, & Morton, 2015; Russell et al., 1998), and point prevalence is 11-13% (Behlau et al., 2012; Charn & Mok, 2012; Leão et al., 2015; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998). The voice is the teacher's main tool for their work, thus any voice problem may negatively impact teachers' physical, emotional, social and economic status (Pemberton et al., 2008, 2010; Roy, Merrill, Thibeault, Gray, et al., 2004; Yiu, 2002), and may also affect students' learning (Lyberg-Åhlander, Haake, Brännström, Schötz, & Sahlén, 2015; Smith, Kirchner, et al., 1998). Teachers with voice problems are more often absent and are more likely to reduce, change, or prematurely terminate their teaching career compared to their vocally healthy peers (Roy, Merrill, Thibeault, Gray, et al., 2004; Smith et al., 1997; Smith, Lemke, et al., 1998; Van Houtte, Claeys, et al., 2011; Yiu, 2002). Absenteeism rates due to vocal problems among teachers vary from 18 to 37% across studies (De Jong et al., 2006; Leão et al., 2015; Pemberton et al., 2010; Roy, Merrill, Thibeault, Parsa, et al., 2004; Smith, Kirchner, et al., 1998; Van Houtte, Claeys, et al., 2011; Yiu, 2002), and have been shown to affect economies mainly due to increased costs for the education system.

Voice disorders found in teachers are most often considered as hyperfunctional problems (Fritzell, 1996; Sliwinska-Kowalska et al., 2006), attributed to excessive or poorly regulated activity of laryngeal and perilaryngeal muscles. Hyperfunctional voice disorders are thought to result from (Roy, 2008; Van Houtte, Van Lierde, & Claeys, 2011) (Roy, 2008;

Van Haute 2011): a) voice misuse or overuse (Koufman & Blalock, 1988; Morrison, Nichol, & Rammage, 1986; Morrison & Rammage, 1993) Morrison, Rammage, Gilles, Pullan, & Hamish, 1983); b) psychological and personality factors that may elevate muscle tension of perilaryngeal muscles and/or inhibit laryngeal muscles (Aronson & Bless, 2009; Rammage et al., 1987; Roy & Bless, 2000; Roy et al., 2000a), and c) compensatory vocal behaviors associated with underlying conditions such as laryngopharyngeal reflux (Koufman et al., 2000), upper respiratory tract infection (Koufman & Blalock, 1982), altered hormonal status (Abitbol et al., 1999; D'haeseleer et al., 2009; Schneider et al., 2004), and laryngeal aging processes (Bielamowicz, 2004).

The causes of voice problems in occupational voice users, as for many other voice disorders, are multifactorial (De Jong et al., 2006; Vilkmann, 2000) and include personal and external (e.g. environmental, demands on the voice) factors. Efforts have been made to increase the evidence for factors associated with occupational voice problems in order to improve occupational health and safety. Personal contributing factors include gender, personality, and psychosocial variables such as stress. Environmental factors such as poor room acoustics, high background noise, and poor air quality (e.g. dust, dryness, humidity, temperature variation, chemical fumes) may lead to voice problems and/or throat symptoms (Åhlander et al., 2014; Geneid et al., 2009; Sala, Hytönen, Tupasela, & Estlander, 1996; Simberg, Sala, Tuomainen, & Ronnema, 2009; Vintturi et al., 2003). Poor air quality also increases the risk of developing laryngitis (Rantala et al., 2012).

Epidemiological, clinical, laboratory, and field studies have investigated a range of factors associated with voice problems in the teaching profession. Epidemiological studies have shown that factors associated with increased risk include female gender, older age, family history of voice disorders, primary school teaching, loud speaking, teaching subject (physical education, music, chemistry), more years of teaching, higher numbers of pupils/students in classroom, noisy environments, poor room acoustics, poor air quality, health conditions (e.g. laryngitis, colds, allergies, rhinitis, reflux), alcohol intake, and stress (Alvear, Martínez, et al., 2010; S. H. Chen et al., 2010; Kooijman et al., 2006; Roy, Merrill,

Thibeault, Parsa, et al., 2004; Russell, 1999; Russell et al., 1998; Sampaio, dos Reis, Carvalho, Porto, & Araújo, 2012; Ubillos et al., 2015; Van Houtte et al., 2012). There is disagreement across studies regarding some of these factors, such as age, teaching subject, years in the profession, and reflux, probably due to differences in the participant samples, sampling procedures, voice outcome measures, and statistical data analysis methods.

Heavy vocal load is noted to be one of the leading factors contributing to voice problems in teachers, and hence field studies have been conducted to better understand how teachers use their voice during the working day and in non-working hours (Åhlander et al., 2014; Hunter & Titze, 2010; Morrow & Connor, 2011; Remacle et al., 2014; I. R. Titze et al., 2007). Field studies have shown associations between increased noise levels, poor room acoustics, and increased vocal load (Bottalico & Astolfi, 2012; Brunskog et al., 2009; Kob et al., 2008; Kristiansen et al., 2014). Rantala et al. (2012) found that greater voice ergonomic risk (based on air quality and room acoustics aspects) was linked to more voice symptoms and higher Voice Handicap Index scores. A systematic review of studies examining work-related factors and voice disorders in teachers found greater risk for teachers who speak in noisy environments, speak loudly, and teach physical education (Cutiva et al., 2013). A recent randomized case-control study of teachers with self-reported voice problems showed that they had more symptoms, higher voice handicap, and longer recovery times than control teachers, but no difference was found on objective assessments of the larynx and voice, or personality, coping, burn-out, and other work related issues (e.g., support) (Åhlander et al., 2012).

While some demographic characteristics, voice use factors, health conditions, and a few organizational aspects of the working environment have been widely examined in previous epidemiological studies, only a few studies have investigated psychosocial factors associated with voice problems in teachers (Alvear, Martínez, et al., 2010; De Jong, 2010; De Jong et al., 2006; Gassull et al., 2010; Nerrière et al., 2009). Voice problems may affect teachers' psychological and social wellbeing. A range of psychological, emotional, and

personality factors have been associated with different types of voice disorders (e.g. functional voice disorders) (Baker, 2008; Dietrich et al., 2008; Roy, 2011; Roy et al., 2000a). Psychosocial factors may increase the risk for developing or maintaining a vocal problem (De Jong et al., 2003; Roy, 2011). Psychosocial factors such as emotions and stress may increase muscle tension and lead to voice problems. Personality has been related to certain voice disorders (Roy, 2011; Roy et al., 2000a). The trait theory of vocal nodules, for example, proposes that neurotic and extroverted personality traits lead to behavioral response biases that give rise to excessive laryngeal muscle hyperfunction (Roy et al., 2000a). Recent studies have shown that teachers with voice problems experience greater stress, anxiety, and/or lower job satisfaction than their vocally healthy peers (Alvear, Martínez, et al., 2010; S. H. Chen et al., 2010; Gassull et al., 2010; Kooijman et al., 2006; Nerrière et al., 2009; Rantala et al., 2012; Van Houtte et al., 2012). A strong association between voice disorders and certain mental illnesses, including general anxiety disorder and major depressive disorder, has also been found (Alvear, Martínez, et al., 2010; Nerrière et al., 2009).

Epidemiological cross-sectional studies are valuable for estimating prevalence rates and for exploring factors associated with an outcome of interest. However, causality cannot be inferred from such studies, and cross-sectional studies provide no information about the sequence of events (i.e. whether exposure to the risk factor occurred before, during or after the onset of an outcome) (Browner, Hulley, & Cummings, 1988; Levin, 2006; Mann, 2003). Further, with the exception of a few studies (e.g., Chen et al., 2010; Sampaio et al., 2012), previous research in this area has typically used a single measure of voice problems, a limited number of independent variables (associated factors), and univariate analysis approaches.

Different voice outcome measures and factors were examined in the current study to take into account the multidimensionality of vocal health (Dejonckere et al., 2001), in line with the World Health Organization's International Classification of Functioning, Disability and Health (ICF) framework. The current study used a range of voice outcome measures

and multivariate analyses to investigate the influences on voice of a large number of potential associated factors. Demographic, psychosocial, teaching-related, working environment, and health factors that have been widely reported in the literature, were examined. In addition, several additional psychosocial factors, such as general self-efficacy and engagement, were investigated.

Method

This cross-sectional epidemiological study used a survey method to investigate factors associated with voice problems in NZ school teachers based on a range of voice outcome measures. The study was approved by the Human Participants Ethics Committee of The University of Auckland (2010/459, 2011/6874).

Participants

Participants were primary and secondary school teachers who participated in a previous study conducted by the authors to establish the prevalence of occupational voice problems (Leão et al., 2015). Teachers from every region of New Zealand (NZ) were asked to indicate their interest in responding to a second online survey that requested details about their voice use. In order to reduce the risk of self-selection bias, there was no mention in the invitation that the focus was on voice problems. In total, 998 teachers expressed their interest. An email with the survey link was sent to those teachers, approximately 8 months after the first survey.

Questionnaire

A self-report online questionnaire was developed to investigate a large range of potential factors associated with voice problems in teachers that have been proposed in previous literature. The questionnaire was designed using the professional version of SurveyMonkey® software (Palo Alto, California, USA), following the recommendations for questionnaire and web survey design utilised in our previous study (Leão et al., 2015). This included the use of short, clear and logical questions, use of 'skip' questions, careful

selection of the day on which the questionnaire was sent to teachers (i.e., the beginning rather than the end of week), and delivery of reminder emails at two-weekly intervals. Teachers had the option of being anonymous or providing their email address if they wished to be considered for the last phase of the study. The first question indicated the inclusion criterion; only teachers who indicated that they had been teaching over the previous 12 months were able to continue to answer the questionnaire and participate in the study. The questionnaire took approximately 35 minutes to complete. Some questions from the first study were repeated to obtain up-to-date responses.

Questions were developed on the basis of the previous survey (Leão et al., 2015), previous literature on voice problems in teachers, and acoustic properties of the NZ teaching environment, the authors' clinical experience, and information provided by teachers about the NZ teaching context and school curriculum. Several questions were adapted from previous questionnaires with permission (Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell et al., 1998; Sala et al., 2009). The online version was tested with a small group of primary and secondary teachers, non-teachers, speech pathology students who were former teachers, and a psychologist, to test for technical, wording, and configuration issues. The questionnaire covered a range of potential factors associated with voice problems in teachers, including demographic, teaching-related demographics, voice-related factors, environmental, psychosocial, and health and life style factors.

Demographic characteristics were gender, age, and ethnicity.

Teaching-related demographics were factors related to professional aspects of teaching including: teaching level (primary or secondary), years of teaching, teaching hours per week, average number of students in teaching environment, and teaching subject.

Voice-related factors were *voice use patterns* and *voice training or voice education* (hours of training or education before or during teacher training), *intense voice use in extra-curricular activities* (hours spent in extra voice activities during the week), and *breaks during*

typical teaching day (number of breaks in which the teacher is able to rest their voice during a typical teaching day; ranging from 0 to >4). For the *voice use patterns* items, teachers rated the frequency of each of 13 vocal behaviors using a three-point Likert scale (1 = 'not at all or very little', 2 = 'a moderate amount', 3 = 'a great deal'). After internal reliability analysis, five items were excluded when the total inter-item correlation was lower than .3 ('sing loudly', 'sing using an unnatural pitch', 'sing with vocal force or strain', 'sing using unnatural voice quality', 'laugh loudly'). Voice use patterns (in a typical work day) were examined using the remaining eight questionnaire items: 'talk loudly', 'talk using an unnatural pitch', 'talk with vocal force or strain', 'talk using an unnatural voice quality (e.g. raspy voice)', 'talk quickly with few pauses', 'shout / yell / scream / cheer', 'clear your throat', and 'cough'. A total score for these 8 items was generated by summing individual item scores.

Environmental factors were teachers' perceptions of room acoustics and air quality. Room acoustic variables were explored in four ways: *noise in the room*, *background noise from outside*, *echo in the room*, and *sound absorption*. Teachers rated the extent to which these aspects made it difficult to use their voice, using a four-point rating scale (1 = 'does not make it difficult at all' to 4 = 'extremely difficult'). Air quality was measured using a five-item scale covering 'dry air quality', 'humid air quality', 'mould or mustiness in room', 'dust in the room', and 'cold or draughty room'. Teachers rated the extent to which these aspects made it difficult to use their voice using four-point rating scale (1 = 'does not make it difficult at all' to 4 = 'extremely difficult'). Air quality was also examined by asking about use of chemical substances in the classroom (type and frequency of use: once a week, twice a week, ≥ twice a week, other).

Psychosocial factors that were investigated included: stress, anxiety, depression, personality, self-efficacy, coping, job satisfaction, and engagement. All these factors, with the exception of *job satisfaction*, were investigated using short standardized questionnaires. *Stress, Anxiety, and Depression* were measured using the DASS21 scale (Henry & Crawford, 2005). The DASS21 is a quantitative measure that comprises 21 items (e.g. "I

found it difficult to work up the initiative to do things” (Depression), “I was worried about situations in which I might panic and make a fool of myself” (Anxiety), “I found it hard to wind down” (Stress) and uses a four-point Likert scale rating for the past week (0 = did not apply to me at all, to 3 = applied to me very much, or most of the time). *Personality* was measured using the Ten-Item Personality Inventory (TIPI) with a seven-point Likert scale (1 = disagree strongly to 7 = agree strongly) (Gosling, Rentfrow, & Swann, 2003). TIPI measures the main personality dimensions (emotional stability, openness to experience, agreeableness, extraversion, and conscientiousness) (McCrae & Costa, 1987). Each dimension has two items with two descriptors (e.g. “I see myself” as: extraverted, enthusiastic; sympathetic, warm; dependable, self-disciplined; calm, emotional stable; open to new experience, complex). *Coping* was measured using the 21-item Coping Inventory for Stressful Situations Scale - Situation Specific Coping (CISS-SSC) (Cohan, Jang, & Stein, 2006; Endler & Parker, 1999), which is divided into three domains: Task-oriented (e.g. “Focus on the problem and see how I can solve it”), Emotion-oriented (e.g. “Blame myself for having gotten into this situation”), and Avoidance coping (e.g. “Take some time off and get away from the situation”). The CISS-SSC uses a 5-point Likert scale from 1 = “not at all” to 5 = “very much”. General *self-efficacy* was measured using the New General Self-Efficacy Scale (NGSE) scale (G. Chen, Gully, & Eden, 2001), which comprises eight items rated on a five-point Likert scale from 1 = “strongly disagree” to 5 = “strongly agree” (e.g. “I will be able to achieve most of the goals that I have set for myself”, “Even when things are tough, I can perform quite well”). *Engagement* was measured using a shortened version of the Engagement scale (Rich, Lepine, & Crawford, 2010). Engagement has been defined as the ability to be physically, emotionally and cognitively present in one’s work; being fully engaged in fulfilling activities should enhance people’s sense of personal efficacy (Maslach & Leiter, 2008). The Engagement scale has 12 items divided into three domains (Physical, Emotional, Cognitive), and uses a 5-point Likert scale (1 = “strongly disagree” to 5 = “strongly agree”). Example items from each of the three domains are: “I exert my full effort to my job”, “I am excited about my job”, and “At work, my mind is focused on my job”. An overall question was used

for *job satisfaction* (“overall how satisfied are you with your job?”) with a 4-point Likert scale varying from 1 = “very dissatisfied” to 4 = “very satisfied”.

Health and lifestyle factors were *hydration* (number of glasses of water per day), *alcohol consumption* (frequency and amount of alcohol intake per week), *smoking* (smoking pack years were calculated for teachers who smoke currently or who smoked in the past for more than a year), *laryngopharyngeal reflux* based on self-reported symptoms within the last month (referred to hereafter as *reflux*) measured using the Reflux Symptoms Index (RSI) scale (Belafsky, Postma, & Koufman, 2002) that comprises nine items rated on a five-point Likert scale (0 = “No Problem” to 5 = “Severe Problem”), *throat infection/laryngitis*, *sinus infections*, and *colds* examined according to the number of episodes in the last 12 months (never, 1-2 episodes, 3-4 episodes, 5-7 episodes, >7 episodes), *asthma* and *hearing problems* (“never diagnosed”, “have been diagnosed”, “current symptoms”), and *other health problems* (e.g. hypothyroidism). Some health factors (e.g. thyroid problems, high blood pressure, pneumonia, cancer, autoimmune disease, neurological disease) had few responses and hence were excluded from the regression analyses.

Voice-related outcome measures

Voice outcome measures were as follows: a) Frequency of voice problems during the year, b) Severity of voice problems during the year, c) V-RQOL total score and its sub-domains (Physical and Functioning, and Socio-Emotional), d) Voice symptoms, and e) Overall voice quality self-rating. These seven outcome measures were chosen to encompass voice impairment, activity, and participation based on the ICF framework (WHO, 2001).

Frequency of voice problems was treated as a dichotomous variable. Teachers were considered to have frequent vocal problems when they reported them more frequently than *every couple of months*, based on the question “*During the past year, how often did you*

have a problem with your voice which prevented you from doing all you wanted to with it?”, as used in our previous study (Leão et al., 2015).

Severity of voice problems was only rated by teachers who reported a voice problem during the past 12 months. Teachers rated the severity of their voice problem during the past 12 months using a four-point scale (1 = ‘slight’, 2 = ‘mild’, 3 = ‘moderate’, 4 = ‘severe’). Teachers who did not report a voice problem were coded as zero (0 = ‘no problem’).

Voice-related quality of life was measured using the Voice-Related Quality of Life (V-RQOL) questionnaire (Hogikyan & Sethuraman, 1999). Three separate outcomes derived from the V-RQOL were explored: Total scores and scores for the sub-domains Physical Functioning and Socio-Emotional. Lower V-RQOL scores indicate poorer voice-related quality of life. The wording of the V-RQOL items makes it suitable for teachers with and without voice problems. These outcomes were treated as continuous variables.

Voice symptoms were quantified based on the frequency of voice symptoms in the past 12 months, using a scale similar to that used in the previous study (Leão et al., 2015). Symptoms were rated according to the *frequency of voice symptoms* in the past 12 months using a 3-point Likert scale (1 = ‘never or rarely’, 2 = ‘sometimes’, 3 = ‘often or always’): *alteration of voice quality* (e.g. hoarseness, roughness, huskiness, strained voice), *vocal effort* (e.g. increased effort or force needed to speak), *vocal fatigue* (e.g. tired voice), *complete loss of voice* (e.g. only whispering is possible), *alteration of voice pitch* (e.g. different pitch than usual such as pitch too high, too low, smaller pitch range, uncontrolled pitch), *voice breaks or cracks during speaking*, *difficulty projecting my voice/weak voice*, *throat discomfort* (e.g. throat pain, dryness, burning, tightness, cough/clearing throat), *breathing difficulties* (e.g. shortness of breath or running out of breath while speaking, noisy breathing), and *singing difficulties* (e.g. difficulty reaching high notes, voice breaks during singing). After internal consistency analysis, three symptoms with item-total correlations

lower than .3 were excluded (complete voice loss, breathing difficulties and singing difficulties), leaving seven symptoms in the scale. A total score was calculated by summing all included symptoms (sum varied from 7 to 21, with 21 indicating greatest frequency of voice symptoms).

Overall voice quality was based on teachers' ratings of overall voice quality during the past 12 months using a 4-point Likert scale (1 = *poor voice quality* to 4 = *excellent voice quality*).

Statistical analysis

IBM SPSS Statistics v.22 software (Armonk, NY, USA) and SAS 9.3 (SAS Institute Inc; Cary, NC, USA) were used for statistical analyses. The data were firstly screened for errors, outliers and missing data (Tabachnick & Fidell, 2012). Categorical variable response options were aggregated when there were too few participants for individual response categories (ethnicity, teaching subject, colds, throat infections, sinus infections, asthma, hearing problems). Teaching subjects were aggregated based on the similarity of vocal demands (1 = music, drama, dance, physical education, sports, outdoor; 2 = science; 3 = languages; 4 = social sciences, health; 5 = national curriculum with/without specific subjects (primary and some intermediate teachers). A breakdown of teaching subjects is shown in Appendices. Descriptive statistics were calculated for the seven voice outcomes. Independent t-tests or Mann-Whitney U tests were used for group comparisons after checking for normality and homogeneity of variance. Item-total correlations (Cronbach's alpha) were calculated to determine the reliability of frequency of voice symptoms, voice use patterns, and air quality scales.

Different types of regression model were fitted to the data to examine associations between factors and voice outcome measures. Four multiple regression models were derived for the continuous dependent variables (V-RQOL Total, V-RQOL Physical Functioning, V-RQOL Social-Emotional, and voice symptoms). A logistic regression model was derived for the dichotomous outcome frequency of voice problems analysis

(dichotomous variable - yes/no). Two ordinal regression models were derived for ordinal dependent variables (severity of voice problem and voice quality self-rating). The models were chosen by forward selection (all regression models) and checked by 'all subsets' regression (for multiple regressions only). The all subsets regression analysis tests all possible subsets of the set of potential independent variables and is used to validate the result obtained by forward selection (Nimon & Oswald, 2013). Age and gender were controlled for in all models. The confidence interval adopted was 95% ($p < 0.05$).

Assumptions for multiple regressions were tested for sample size, normality, linearity, multicollinearity, and homoscedasticity. Multicollinearity was investigated using variance inflation factors (VIFs) and condition indices in combination with the proportions of variance accounted for by each principal component for each variable. Due to the skewness of the V-RQOL Total and sub-domain scores, the residuals from the model using this original form were slightly skewed and did not conform well to a normal distribution when a Q-Q plot was examined. For this reason, these variables were transformed by reversing and then taking the log. The number 101 was used as the maximum rather than 100 so that the reversed variable would have a minimum of 1 instead of 0, which is able to be logged (whereas 0 is not). The transformed outcome was $\log(101 - y)$, where y is the original outcome variable for voice related quality of life.

Multiple linear regression was performed using the REG procedure in SAS. A forward selection of all variables was performed (all variables were added in the model, one at the time). Variables were entered up to the .05 level of significance. The REG procedure was also used to perform all subsets regression using R-squared as the criterion of best model. If the forward selected model chose five variables in addition to gender and age, then the best fitting model with seven variables was examined from the all subsets regression output. For all continuous outcomes, with the exception of V-RQOL Emotional, the two methods of variable selection (forward and all subsets regressions) gave the same result providing additional confidence in using forward selection. For V-RQOL Social Emotional, the best fitting model with a total of nine variables from the all subsets regression included mostly the

same variables derived using the forward selection regression analysis, but did not include conscientiousness and task-oriented coping. The variables from the all subsets regression were chosen to be those in the final model for V-RQOL Social-Emotional. For multiple regression models, all variables except ethnicity and teaching subject were treated as continuous predictors as all variables apart from these two had a clear order.

For the categorical outcomes (frequency of voice problems, severity of voice problems, overall voice quality), direct logistic and ordinal regressions with a cumulative logit link were performed using the LOGISTIC procedure in SAS. A forward selection of all variables was performed. Variables were entered up to the .05 level of significance. For logistic regressions, Nagelkerke R-squared values were determined (Nagelkerke, 1991). The following variables were treated as categorical: gender, age, ethnicity, teaching level, teaching subject, hearing problem, colds, sinus infections, throat infections/laryngitis, asthma, hydration, and alcohol.

Results

Teachers from different regions of New Zealand, including rural, small towns and larger cities, responded to the questionnaire. Out of 998 emails sent to teachers who expressed interest, 99 emails were returned automatically due to problems with the email address (e.g. teachers had changed school or retired, incorrect email address, mail box full). Therefore, 899 teachers received the study invitation (note this does not mean they read the email). A response rate of 70.5% was achieved with 634 teachers answering the questionnaire. Of the 634 teachers who responded to the questionnaire, 62 were excluded due to incomplete responses to the main voice-related and demographic questions. Thus, the final cohort comprised 572 teachers, 74.8% females (n = 428) and 25.2% males (n = 144), ranging in age from 20 to 75 years (age bands: ≤29 years 8.4%, n = 48; 30-39 years 17.8%, n = 102; 40-49 years 24.5%, n = 140; 50-59 years 32.5%, n = 186; 60+ years 16.8%, n = 96). The ethnicity breakdown was: NZ European/Pākehā (79.7%, n = 456), Māori or Pacific Islander (6.1%, n = 35), European (9.6%, n = 55), and other (4.5%, n = 26). Of the

572 teachers, 69.1% (n = 395) were secondary teachers and 30.9% (n = 177) were primary teachers.

Table 4 summarizes the descriptive statistics for the outcome measures for teacher with voice problems (VP) and non-voice problems (nVP). Teachers with voice problems had significantly poorer scores for all voice outcomes (V-RQOL Total score: $U = 18.34$, $z = -10.64$, $p < .001$, $r = 0.44$; V-RQOL Socio-Emotional: $U = 24.54$, $z = -9.41$, $p < .001$, $r = 0.39$; V-RQOL Physical-Functioning: $U = 18.9$, $z = -10.36$, $p < .001$, $r = 0.43$; Overall voice quality: $U = 15.5$, $z = -12.7$, $p < .001$, $r = 0.53$; Severity of voice problems: $U = 58.7$, $z = -11.3$, $p < .001$, $r = 0.56$; Voice symptoms: $t(570) = -17.003$, $p < .001$, $d = 1.44$).

Table 5 shows the overall regression model information for the seven voice outcomes. Based on Nagelkerke's R-squared and R-square (R^2) measures, seven models were obtained that accounted for 25.7% to 50% of the variance in the outcome measures. All models, with the exception of the model for V-RQOL Socio-Emotional ($R^2 = 25.75\%$), were robust ($R^2 > 35\%$) (voice symptoms, V-RQOL Total score, V-RQOL Physical-Functioning, overall voice quality, frequency of voice problems, and severity of voice problems). R^2 values were the highest for the regression models for voice symptoms and V-RQOL Total score ($R^2 = 41\%$ and 50% , respectively). R^2 provides an indication of the contribution of the chosen explanatory factors to predicting the outcomes (Renaud & Victoria-Feser, 2010).

Table 4

Descriptive Data (Mean, Median, Standard Deviation, Range, Minimum and Maximum) for Voice-related Outcomes (for Total Sample and According to Frequency of Voice Problems Groups)

Outcome	VP						No VP						Total					
	<i>M</i>	<i>Md</i>	<i>SD</i>	Range	Min	Max	<i>M</i>	<i>Md</i>	<i>SD</i>	Range	Min	Max	<i>M</i>	<i>Md</i>	<i>SD</i>	Range	Min	Max
V-RQOL Total	87.01	90.00	14.14	70.0	30.0	100	96.48	100.00	5.71	32.5	67.5	100	93.02	97.50	10.70	70.0	30.0	100
V-RQOL Socio-Emotional	91.57	100.00	14.13	68.8	31.3	100	98.90	100.00	3.78	37.5	62.5	100	96.22	100.00	9.71	68.8	31.3	100
V-RQOL Physical Functioning	83.97	87.50	15.71	83.3	16.7	100	94.87	100.00	7.90	50.0	50.0	100	90.89	95.83	12.53	83.3	16.7	100
Voice Symptoms	13.26	9.00	2.70	14.0	7.0	21	9.63	9.00	2.31	11.0	7.0	18	10.96	11.00	3.02	14.0	7.0	21
Overall Voice Quality	2.37	3.00	0.70	3.0	1.0	4	3.24	3.00	0.64	3.0	1.0	4	2.92	3.00	0.78	3.0	1.0	4
Severity of Voice Problems	2.34	1.00	0.70	3.0	1.0	4	1.13	1.00	1.26	4.0	0.0	4	1.57	2.00	1.24	4.0	0.0	4

Note: VP (n = 209); no VP (n = 363); Total (N = 572); V-RQOL = Voice-Related Quality of Life.

Table 5

Overall Regression Model Results for Each Voice Outcome Measure

Outcome measure	Regression model	Overall model		
		Nagelkerke's R-squared	Likelihood Ratio (df)	p
Frequency of VP	Logistic regression	35.30%	161.21 (9)	<0.001
Severity of VP	Ordinal regression using cumulative logit	37.00%	244.78 (13)	<.0001
Overall voice quality	Ordinal regression using cumulative logit	36.10%	224.35 (10)	<.0001
		R ²	F value (df)	p
V-RQOL Total Score	Multiple Regression	41.10%	43.22 (9)	<.0001
V-RQOL Social Emotional	Multiple Regression	25.70%	32.44 (6)	<.0001
V-RQOL Physical Functioning	Multiple Regression	38.90%	45.73 (8)	<.0001
Voice Symptoms	Multiple Regression	50.00%	62.95 (9)	<.0001

Note: df = degrees of freedom

Significant factors in each regression model are displayed in Tables 6 and 7. Reflux and voice use patterns contributed to the regression models for every outcome. The regression coefficient indicates the contribution (e.g. increase or decrease) of each independent variable to the regression equation, holding all other independent variables constant (Nathans et al., 2012). The regression coefficient indicates the effect of a unit change in the predictor variable on the outcome (dependent variable). For instance, for the V-RQOL outcome models, noise in the room had exponentiated regression coefficients of 1.133 to 1.312 (V-RQOL Total = 1.278, $p < .0001$; V-RQOL Social-Emotional = 1.133, $p = .011$; V-RQOL Physical-Functioning = 1.312, $p = .027$), indicating that a greater than 1 scale point increase in the teachers' rating of the noise was associated with a 1.133 - 1.312 V-RQOL score reduction, while all other predictors variables were held constant (Table 6).

Based on the change in R-square, across all models the most influential variable, which explains most variation in the outcome, was reflux (Table 6). For most of the models,

the second most influential variable was voice use patterns, with the exception of the voice symptoms outcome for which voice use patterns was the most influential variable. The effects of different predictors on the model are indicated by the odds ratios for the logistic and ordinal regression models (frequency of VPs, severity of VPs, and overall voice quality; see Figure 5). For the frequency of VP outcome model, the highest odds ratio was observed for age (<30 vs 60+ years) and throat infection (0 vs >2 episodes).

The direction of the relationship between predictors and outcomes shows that higher scores for reflux and voice use patterns were associated with more frequent and more severe voice problems, higher frequency of voice symptoms, poorer overall voice quality, and poorer (lower) voice-related quality of life scores (Total score and sub-domains) (Tables 6 and 7). Greater scores for noise in the room were associated with lower V-QORL scores.

More voice rest periods during the teaching day were associated with better voice quality and higher V-RQOL Total scores. Greater voice training hours were also linked to increased V-RQOL Total scores and Physical Functioning. Increased hours engaged in activities involving extra voice use outside of teaching hours were associated with fewer voice symptoms. Amongst health and lifestyle factors explored, other than reflux, throat infections and colds were associated with voice outcomes. More episodes of laryngitis (more than two episodes per year) were associated with increased odds of having voice problems. Teachers who reported over than two episodes of laryngitis per year, were more likely to report frequent (OR = 3.16) and severe (OR = 3.4) voice problems (Table 5). Fewer episodes of colds (≤ 2 per year) were associated with better voice quality

Several psychosocial factors were associated with voice outcomes. Higher stress scores were associated with lower V-RQOL Total and Physical-Functioning scores. Higher scores for extraversion were associated with higher scores for V-RQOL outcomes (more extroverted teachers had better V-RQOL); higher scores on agreeableness were associated with more voice symptoms; and higher openness to experience scores were associated with smaller odds for frequency of voice problems. Better scores for the general self-efficacy

measures were associated with fewer voice symptoms. Greater job satisfaction and use of an avoidance coping style were associated with better voice quality.

All factors contributing to the models and the respective p values, regression coefficients, odds ratios, and interpretations are portrayed in Tables 6 and 7.

Table 6

Multiple Linear Regression Results for Voice Symptoms and V-RQOL Outcome Measures

Outcome measure	Coefficient/ Effect size	Exponentiated Coefficient	SE	p	Difference in R-squared with Variable Removed	Reverse Sign of Coefficient **	Effect/Interpretation
V-RQOL Total							
Gender	0.116	1.123	0.09	0.2170	0.200	-	NS
Age	0.049	1.051	0.03	0.1529	0.200	-	NS
Stress	0.030	1.030	0.01	0.0019	1.300	-	higher stress scores associated with poorer V-RQOL
Noise In Room	0.245	1.278	0.05	<.0001	2.600	-	more noise in the room associate with lower V-RQOL
Reflux	0.043	1.044	0.01	<.0001	5.700	-	higher scores associated with lower V-RQOL
Extraversion	-0.113	0.894	0.03	0.0001	1.700	+	higher scores associated with higher V-RQOL
Voice Rest Breaks	-0.072	0.931	0.04	0.0844	0.300	+	more breaks associated with higher V-RQOL
Voice Training Hrs	-0.004	0.996	0.001	0.0027	0.900	+	more voice training hours associated with higher V-RQOL
Voice Use Patterns	0.090	1.094	0.02	<.0001	2.700	-	higher scores associated with lower V-RQOL
V-RQOL Socio-Emotional							
Gender	0.060	1.062	0.098	0.5377	0.001	-	NS
Age	0.076	1.079	0.036	0.0329	0.012	-	older age associated with lower V-RQOL-SocE
Noise In Room	0.125	1.133	0.049	0.0114	0.008	-	more noise in room associate with lower V-RQOL-SocE
Reflux	0.031	1.032	0.006	<.0001	0.042	-	higher scores associated with lower V-RQOL-SocE
Extraversion	-0.141	0.868	0.03	<.0001	0.029	+	higher scores associated with higher V-RQOL-SocE
Voice Use Patterns	0.104	1.110	0.019	<.0001	0.041	-	higher scores associated with lower V-RQOL-SocE
V-RQOL Physical Functioning							
Gender	0.137	1.147	0.105	0.1918	0.002	-	NS
Age	0.048	1.049	0.038	0.2098	0.002	-	NS
Chemicals	-0.240	0.787	0.137	0.0805	0.003	+	NS
Stress	0.035	1.036	0.011	0.0010	0.012	-	higher scores associated with lower V-RQOL-PhyFunc
Extra Voice Use	-0.010	0.990	0.011	0.3501	0.001	+	NS

Noise In Room	0.272	1.312	0.053	<.0001	0.027	-	higher scores associated with lower V-RQOL-PhyFunc
Reflux	0.047	1.048	0.006	<.0001	0.060	-	higher scores associated with lower V-RQOL-PhyFunc
Extraversion	-0.113	0.893	0.033	0.0006	0.013	+	higher scores associated with higher V-RQOL-PhyFunc
Voice Training Hrs	-0.004	0.996	0.001	0.0073	0.008	+	higher scores associated with higher V-RQOL-PhyFunc
Voice Use Patterns	0.091	1.096	0.020	<.0001	0.022	-	higher scores associated with lower V-RQOL-PhyFunc

Voice Symptoms

Gender	0.349		0.214	0.1037	0.002		
Age group	-0.146		0.078	0.0633	0.005		
Extra Voice Use	-0.037		0.019	0.0460	0.006		higher scores associated with fewer symptoms
Self-efficacy	-0.368		0.144	0.0111	0.006		higher scores associated with fewer symptoms
Reflux	0.090		0.013	<.0001	0.042		higher scores associated with more symptoms
Agreeableness	0.234		0.088	0.0078	0.006		higher scores associated with more symptoms
Throat Infections/ Laryngitis	0.561		0.142	<.0001	0.014		higher scores associated with more symptoms
Voice Training Hrs	-0.005		0.003	0.0516	0.003		NS
Voice Use Patterns	0.473		0.039	<.0001	0.131		higher scores associated with more symptoms
European ethnicity	-0.705		0.305	0.0210	0.005		Europeans tended to have fewer symptoms than other ethnic groups
Teaching Subject	-0.857		0.346	0.0136	0.005		Teachers teaching music, drama, dance, PE, sports, or outdoor education had lower mean symptom scores than those teaching other subjects. Specifically, we found that the mean symptom score for teachers teaching music, drama, dance, PE, sports, or outdoor education was 0.857 units lower than that for teachers not teaching these subjects

Note: Lower V-RQOL scores indicate poorer voice-related quality of life. Higher scores on voice symptoms are worse (higher number and frequency of symptoms). NS = non-significant.

Table 7

Logistic and Ordinal Regression Results and Interpretation for Frequency of Voice Problems, Severity of Voice Problems, and Overall Voice Quality Outcomes

Outcome measure	OR	Coefficient/ Estimate	SE	p	Wald 95% CI	Difference in R-squared with Variable Removed	Effect/Interpretation
Frequency of VP							
Gender: Male vs Female	0.793	-0.232	0.248	0.349	0.487-1.29	0.0015	NS
Age Bands: <30	2.366	0.861	0.431	0.032	1.016-5.511	0.0177	Compared to those age 60+, the odds of having a voice problem were 2.37 times higher for those aged less than 30
Age Bands: 30-39 vs 60+	1.222	0.200	0.368	0.783	0.594-2.514		No significant difference in the odds of voice problems between those aged 30-39 and those aged 60+
Age Bands: 40- 49 vs 60+	0.814	-0.206	0.347	0.022	0.412-1.607		Those aged 40-49 were less likely to have a voice problem than those aged 60+. Specifically, the odds of having a voice problem for those aged 60+ was 1.229 times more than that for those aged 40 - 49 (1/.814 = 1.229)
Age Bands: 50-59 vs 60+	1.567	0.449	0.324	0.289	0.83-2.958		No significant difference in the odds of voice problems between those aged 50-59 and those aged 60+
Reflux	1.093	0.089	0.016	<.0001	1.06-1.127	0.0664	Higher reflux scores were associated with a greater odds of voice problems. A one unit increase on the reflux score was associated with an increase in the odds of a voice problem by a factor of 1.093
Voice Use Pattern	1.203	0.185	0.043	<.0001	1.105-1.31	0.0345	Higher scores were associated with a greater odds of voice problems. A one unit increase on the score was associated with an increase in the odds of a voice problem by a factor of 1.203
Extra Voice Use	0.953	-0.048	0.028	0.086	0.902-1.007	0.0065	NS
Throat Infections/Laryngitis: 0 vs >2 episodes	0.322	-1.133	0.337	0.014	0.166-0.624	0.0236	Those with no episodes were less likely to have a voice problem. Specifically, the odds of a voice problem for those with more than 2 episodes were 3.106 times larger than than for those with no episodes (1/.322 = 3.106)
Throat Infections/ Laryngitis: 1-2 vs >2 episodes	0.339	-1.083	0.323	0.021	0.18-0.638		Those with 1-2 episodes were less likely to have a voice problem. Specifically, the odds of a voice problem for those with more than 2 episodes were 2.950 times larger than than for those with no episodes (1/.339 = 2.950)
Openness to Experiences	0.822	-0.196	0.100	0.049	0.677	0.0069	Higher scores were associated with a smaller odds of voice problems. A one unit increase on the score was associated with a decrease in the odds of a voice problem by a factor of 0.822
Coping: Task Oriented	1.029	0.028	0.020	0.150	0.99	0.0037	NS
Severity of VP							
Gender: Male vs Female	1.385	0.326	0.191	0.088		0.0036	NS
Age Bands: <30 vs 60+	1.373	0.317	0.444	0.476		0.0018	NS
Age Bands: 30-39 vs 60+	1.189	0.173	0.360	0.631			NS
Age Bands: 40 - 49 vs 60+	0.951	-0.051	0.308	0.870			NS
Age Bands: 50-59 vs 60+	0.993	-0.007	0.258	0.979			NS

Reflux	0.917	-0.086	0.013	<.0001	0.0628	Higher scores were associated with more severe voice problems. That is, a one unit increase in reflux score was associated with an increase the odds having a severe voice problem by a factor or 1.091 (1/.917). Equivalently, a ten unit increase in reflux score was associated with an increase the odds of having a severe voice problem by a factor of 2.363 (1/exp(-.086*10)).
Throat Infections/Laryngitis: 0 vs >2 episodes	3.367	1.214	0.271	<.0001	0.0502	Those with more than 2 episodes had more severe voice problems. That is, the odds of having a severe voice problem were 3.367 times larger for those with more than 2 episodes compared to those with no episodes (exp(1.214)=3.367).
Throat Infections/Laryngitis: 1-2 vs >2 episodes	1.169	0.156	0.256	0.5407		NS
Voice Use Pattern	0.876	-0.133	0.035	0.0001	0.0176	Higher scores were associated with more severe voice problems. - That is, a one unit increase in voice pattern use score was associated with an increase the odds having a severe voice problem by a factor or 1.142 (1/0.876).
Teaching Yrs	1.029	0.029	0.011	0.0077	0.0089	More years teaching were associated with less severe voice problems. That is, a one year increase in teaching was associated with a decrease the odds having a severe voice problem by a factor of .972 (1/1.029). Equivalently, a ten year increase in teaching years was associated with a decrease the odds of having a severe voice problem by a factor of .748 (1/exp(.029*10)).
Stress	1.035	0.034	0.019	0.0688	0.0039	NS
Chemicals: 1 vs 0	0.592	-0.524	0.240	0.0291	0.0055	"use >2x/week" was associated with more severe voice problems. That is, the odds of having a severe voice problem were 1.689 times larger for those in the "over 2x week" group compared to those in the "less 2x week" group (1/.592=1.689).
Smoking Pack Yr	1.034	0.033	0.015	0.0223	0.0067	Higher values were associated with less severe voice problems. That is, a one unit increase in smoking was associated with a decrease the odds having a severe voice problem by a factor of .967 (1/1.034). Equivalently, a five unit increase in smoking was associated with a decrease the odds of having a severe voice problem by a factor of .848 (1/exp(.033*5)).
Overall voice quality						
Gender: Male vs Female	0.434	-0.835	0.203	<.0001	0.0226	Males had better voice quality than females. The odds of being in voice quality group 1 (poor) compared to being in the other groups was 2.304 times larger for females compared to males (1/.434 = 2.304). The odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 was 2.304 times larger for females compared to males (1/.434= 2.304). The odds of being in voice quality group 3 or worse compared to being in the group 4 (excellent) was 2.304 times larger for females compared to males (1/.434= 2.304). That is, the odds of being in group 4 (excellent) were 2.304 times larger for males compared to females.
Age Bands: <30 vs 60+	0.383	-0.959	0.369	0.0093	0.0138	Age group <30 had better voice quality, on average, than age group 60+. The odds of being in voice quality group 1 (poor) compared to being in the other groups was 2.611 times larger for those in the 60+ age group compared to those in the <30 age group (1/.383= 2.611). The odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 was 2.611 times larger for those in the 60+ age group compared to those in the <30 age group (1/.383= 2.611). The odds of being in voice quality group 3 or worse compared to being in the group 4 (excellent) was 2.611 times larger for those in the 60+ age group compared to those in the <30 age group (1/.383= 2.611). That is, the odds of being in group 4 (excellent) were 2.611 times larger for those aged <30 compared to those aged 60+.
Age Bands: 30-39 vs 60+	0.638	-0.450	0.295	0.1268		NS
Age Bands: 40-49 vs 60+	0.637	-0.452	0.267	0.0912		NS
Age Bands: 50-59 vs 60+	0.954	-0.047	0.250	0.8512		NS
Reflux	1.086	0.082	0.012	<.0001	0.0635	Higher reflux scores were associated with poorer voice quality. A one unit increase in reflux score was associated with an increase the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor or 1.086. Equivalently, a ten unit increase in reflux score was associated with an increase the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor or 2.271 (exp(.082*10)). A one unit increase in reflux score was associated with an increase the odds of being in

Voice Use Pattern	1.212	0.192	0.037	<.0001	0.0362	voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor or 1.086. Equivalently, a ten unit increase in reflux score was associated with an increase the odds of being in voice group 2 or worse compared to being in the groups 3 or 4 by a factor or 2.271 ($\exp(.082*10)$). A one unit increase in reflux score was associated with an increase the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor or 1.086. Equivalently, a ten unit increase in reflux score was associated with an increase the odds of being in voice group 3 or worse compared to being in the group 4 by a factor or 2.271 ($\exp(.082*10)$). A one unit decrease in reflux score was associated with a decrease the odds of being in voice quality group 4 (excellent) by a factor or 1.086. Equivalently, a ten unit decrease in reflux score was associated with a decrease the odds of being in voice group 4 by a factor or 2.271 ($\exp(.082*10)$). Higher scores were associated with poorer voice quality. A one unit increase in voice use pattern score was associated with an increase the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor or 1.212. A one unit increase in voice use pattern score was associated with an increase the odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor or 1.212. A one unit increase in voice use pattern score was associated with an increase the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor or 1.212. That is, a one unit decrease in voice use pattern score was associated with a decrease the odds of being in voice quality group 4 (excellent) by a factor or 1.212.
Colds: <2 vs >2 episodes	0.581	-0.544	0.197	0.0059	0.0100	Those with < 2 colds had better voice quality than those with >2 colds. The odds of being in voice quality group 1 (poor) compared to being in the other groups was 1.721 times larger for those with >2 colds compared to those with <2 colds ($1/.581 = 1.721$). The odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 was 1.721 times larger for those with >2 colds compared to those with <2 colds ($1/.581= 1.721$). The odds of being in voice quality group 3 or worse compared to being in the group 4 (excellent) was 1.721 times larger for those with >2 colds compared to those with <2 colds ($1/.581= 1.721$). That is, the odds of being in group 4 (excellent) were 1.721 times larger for those with <2 colds compared to those with >2 colds.
Voice Rest Periods	0.769	-0.263	0.086	0.0022	0.0121	More voice breaks were associated with better voice quality. One extra voice break was associated with a decrease the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor or 0.769. One extra voice break was associated with a decrease the odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor or 0.769. One extra voice break was associated with a decrease the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor or 0.769. That is, one extra voice break was associated with an increase the odds of being in voice quality group 4 (excellent) by a factor or 1.300 ($1/.769=1.300$).
Job Satisfaction	0.681	-0.384	0.113	0.0006	0.0148	Higher job satisfaction scores were associated with better voice quality. A one unit increase in job satisfaction score was associated with a decrease the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor or 0.681. A one unit increase in job satisfaction score was associated with a decrease the odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor or 0.681. A one unit increase in job satisfaction score was associated with a decrease the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor or 0.681. That is, a one unit increase in job satisfaction score was associated with an increase the odds of being in voice quality group 4 (excellent) by a factor or 1.468 ($1/.681=1.468$).

Coping: Avoidance	0.963	-0.038	0.016	0.0218	0.0065
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Higher scores were associated with better voice quality. A one unit increase in avoidance score was associated with a decrease the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor of 0.963. Equivalently, a five unit increase in emotion score was associated with a decrease the odds of being in voice quality group 1 (poor) compared to being in the other groups by a factor of 0.827 ($\exp(-.038*5)=.827$). A one unit increase in avoidance score was associated with a decrease the odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor of 0.963. Equivalently, a five unit increase in emotion score was associated with a decrease the odds of being in voice quality group 2 or worse compared to being in the groups 3 or 4 by a factor of 0.827 ($\exp(-.038*5)=.827$). A one unit increase in avoidance score was associated with a decrease the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor of 0.963. Equivalently, a five unit increase in emotion score was associated with a decrease the odds of being in voice quality group 3 or worse compared to being in the group 4 by a factor of 0.827 ($\exp(-.038*5)=.827$). That is, a one unit increase in avoidance score was associated with an increase the odds of being in voice quality group 4 (excellent) by a factor of 1.038 ($1/.963=1.038$). Equivalently, a one unit increase in emotion score was associated with an increase the odds of being in voice quality group 4 (excellent) by a factor of 1.209 ($1/\exp(-.038*5)=1.209$).

Note: NS = not significant.

Odds Ratios with 95% Wald Confidence Limits

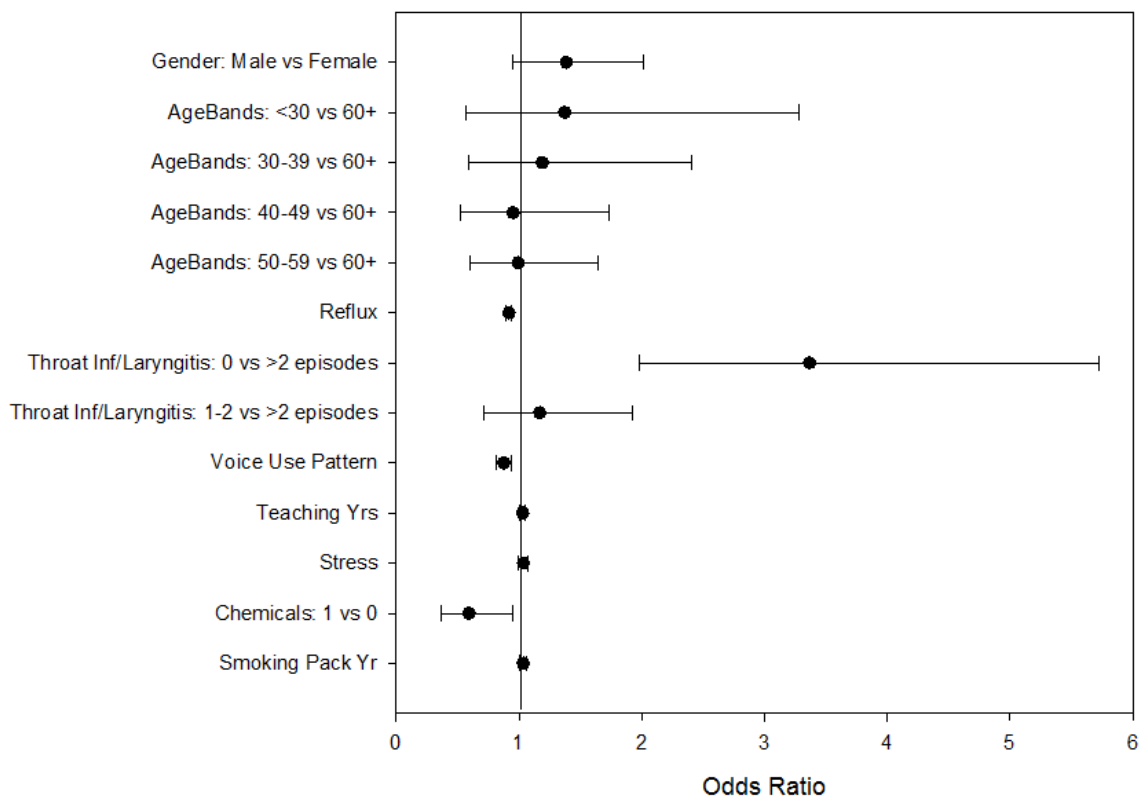


Figure 5. Odds ratios for variables that significantly contributed to the severity of VP outcome model (logistic regression model).

Discussion

The current study found that a number of different categories of factors were associated with voice problems. Reflux and voice use patterns contributed to all the voice outcomes investigated. Noise in the room, extraversion, stress, and throat infections contributed to three of the seven regression models. Other factors associated with the voice outcomes were voice rest periods, voice training/education, laryngitis, chemical exposure, job satisfaction, general self-efficacy, avoidance coping, open to experiences, and agreeableness.

There were significant group differences between teachers with and without self-reported VPs for all voice outcomes measures, thus supporting the validity of the selected outcome measures. Consistent with this finding, a recent randomized case-control study of teachers with self-reported voice problems also showed that they had more symptoms, higher VHI scores, and longer recovery times than control teachers (Åhlander et al., 2012).

Gastro-esophageal reflux disease has been identified in previous research as being associated with voice disorders. Reflux is a high-prevalence disease (El-Serag, Becher, & Jones, 2010) that occurs in approximately 50% of people with laryngeal and voice disorders (Koufman, 1991; Koufman et al., 2000). The aetiology of reflux is multifactorial; the most common causal and risk factors reported are: late-night eating, lying down after eating, tight clothes, overeating/obesity, consumption of high-fat and fried food, carbonated, caffeinated and acidified beverages, alcohol, smoking, and oesophageal dysmobility (Koufman, 2014). In reflux disease, either the lower or upper oesophageal sphincter is faulty (Koufman, 2014). The airway (e.g. laryngopharyngeal epithelium) is fragile and can be easily damaged by the gastric reflux. To our knowledge, few studies have reported reflux symptoms in teachers, although a relationship between reflux and voice problems has been reported for teachers (Fernández & López, 2003). In a cohort of treatment-seeking professional voice users (59% were teachers), reflux was the third most common diagnosis documented (Van Houtte et al., 2010). A higher occurrence of gastrolaryngeal reflux has been observed in a clinical study of

dysphonic teachers compared with non-teacher control participants (Pereira, Tavares, & Martins, 2015). Reflux among teachers may be related to busy schedules affecting lifestyle and dietary habits. We acknowledge, however, that the largest effect for reflux in the current study was for voice-related quality of life (Total score) and the second largest effect was for the voice symptoms measure. Questions on the Reflux Symptom Index overlap with the voice symptoms measure, and this may inflate the contribution as they are, in part, measuring the same thing. We also acknowledge that the RSI is a self-report measure and that a more objective measure of reflux such as ambulatory 24-hour pH monitoring (Wiener et al., 1988) may be useful in future studies for clarifying the significance of reflux for different voice outcomes.

The second factor that contributed to all models was voice use patterns. The different behaviors included in the voice use patterns scale had good internal consistency. Voice use patterns reflected unfavourable voice behaviors such as speaking in an uncomfortable loudness or pitch level, shouting, clearing the throat and other behaviors considered to be potentially harmful. The more negative vocal behaviors teachers engaged in during their work at school, the worse were their voice related quality of life scores, voice quality, voice symptoms, and frequency and severity of voice problems. Current findings corroborate previous studies showing an association between voice problems and voice use patterns such as speaking loudly, shouting, and effort to speak in teachers (Araújo et al., 2008; S. H. Chen et al., 2010; Smolander & Huttunen, 2006). Vocal abuse/misuse has been recognized as common in teachers and as one of the causes of their hyperfunctional voice problems (Koufman, 1991; Koufman & Blalock, 1982; Morrison & Rammage, 1993). Misuse of phonation and respiratory muscles can contribute to changes in voice function (at the vocal fold and perilaryngeal levels) (Van Houtte, Van Lierde, et al., 2011). The current finding is consistent with previous studies showing a relationship between vocal hyperfunction and vocal attrition across different populations (Aronson & Bless, 2009; Koufman & Blalock, 1982, 1991; Morrison & Rammage, 1993).

Among the environmental factors investigated, noise in the room contributed to the regression models, particularly to V-RQOL outcomes, and chemical exposure contributed to severity of voice problems. Increased noise levels, as perceived by the teachers, were associated with poorer voice-related quality of life (total and sub-domain scores). In general, noise in the classroom reflects internal noise related to the teaching style, number of children in the class, classroom acoustics, equipment in the classroom, teaching activities, and behaviors of each student and the class as a whole (Shield & Dockrell, 2008). Previous epidemiological studies have shown increased risk for voice disorders associated with high levels of background noise (Lee, Lao, & Yu, 2010; Medeiros et al., 2008; Preciado-López et al., 2008; Sampaio et al., 2012). Field studies have found a positive correlation between ambient noise levels and teachers' vocal intensity (Bottalico & Astolfi, 2012). Higher noise levels are likely to lead to an increase in children's and teachers' voice levels due to the Lombard effect (Junqua, 1996), potentially accompanied by a rise in fundamental frequency (Debruyne & Buekers, 1997; Gramming, Sundberg, Ternström, Leanderson, & Perkins, 1988). Consequently vocal load is increased, and may result in vocal hyperfunction. Additionally, the intelligibility of the teacher's speech for the students may be affected negatively by high noise levels in the teaching environment (Shield & Dockrell, 2003). Thus, speaking in a noisy environment requires greater vocal effort, potentially leading to vocal fatigue and/or vocal dysfunction. Environmental noise has also been associated with stress and other changes (e.g., cardiovascular) in the body (Basner et al., 2014). Stress has been associated with voice problems and this relationship is discussed further below. The association between elevated use of chemicals (e.g. by science teachers) and more severe voice symptoms is consistent with previous studies (Roto & Sala, 1996; Sala et al., 1996). Chemical substances may trigger respiratory allergies or inflammation in the laryngeal mucosa, and consequently may lead to voice or throat symptoms (Simberg et al., 2009).

Voice rest is an important factor for vocal fold recovery (Bottalico, Pavese, Astolfi, Hunter, et al., 2014; Bottalico, Pavese, Astolfi, & Hunter, 2014; I. R. Titze et al., 2007), especially in vocally demanding professions such as teaching. In the current study,

increased voice rest periods during the teaching day were associated with better self-ratings of voice quality and voice-related quality of life. This result suggests that teachers need to better manage their time so that they can schedule regular voice rest breaks at work. Recently, Titze and Hunter (2015) stressed the importance of including more pauses and dialogue (rather than monologue) in daily vocal activities to reduce the duration of speaking.

Increased hours of voice training/education were associated with higher V-RQOL Total and Physical Functioning scores. This finding is consistent with previous reports indicating that lack of voice training increases the risk of voice problems in teachers (Simberg, Laine, Sala, & Ronnema, 2000; Vilkmann, 2000). Several researchers have examined the effects of voice training and voice education in the teaching population (Ilomaki et al., 2008; Pizolato et al., 2013), and it seems that a combination of vocal hygiene plus vocal training not only once, but regularly revisited throughout the teaching year, reduces the risk of voice problems in teachers. Improvements in teachers' V-RQOL scores after educational voice intervention (voice training plus vocal hygiene education, or the latter only) have been reported previously (Pizolato et al., 2013). Our findings indicate that it is important to address the impact of environmental factors on voice during voice education and encourage the use of an environmental assessment using a protocol such as the checklist proposed by Sala et al. (2009).

A surprising result was that increased hours engaged in activities involving extra voice use outside teaching work was associated with fewer voice symptoms. One possible explanation is that the teachers from the current sample who were engaged in these extra activities could do this safely because they had more robust voices due to physiological and/or behavioral factors.

The finding that teachers who teach music, drama, and physical education were more likely to report fewer voice symptoms contradicts previous literature, which suggests that these teachers are at greater risk for developing voice disorders due to the vocal demands associated with those subject areas. It may be, however, that these teachers have more robust voices. Teachers with more vulnerable voices may be less likely to choose

teaching specialties that require more demanding voice use. Further, physical education teachers are likely to be in better health and physical shape, and in turn may be less vocally vulnerable. Future studies should consider the inclusion of physical exercise or other health indicators to investigate this further.

Psychological factors may play an important role in the development and maintenance of certain voice disorders in teachers. Most voice problems in teachers are known to be functional and, in particular hyperfunctional (involving dysregulated laryngeal and perilaryngeal muscle tension and constriction) (Hillman, Holmberg, Perkell, Walsh, & Vaughan, 1989), and these have been attributed to many sources including personality and psychological factors such as stress, anxiety, coping. Psychological and/or personality factors are thought to “induce elevated perilaryngeal tension and/or muscular laryngeal inhibition” (Roy, 2008, p. 195). Increased arousal and anxiety have been associated with elevated tension in the laryngeal region (Nichol, Morrison, & Rammage, 1993). In the current study, higher stress scores were associated with poorer V-RQOL Total and Physical Functioning scores, consistent with the proposal of Nichol et al. (1993) and with many other authors (e.g., Aronson & Bless, 2009). Similarly, an association between stress and voice problems in teachers has been demonstrated by a few other authors (Alvear, Martínez, et al., 2010; S. H. Chen et al., 2010; Nerrière et al., 2009; Rantala et al., 2012; Van Houtte et al., 2012). Teachers with voice problems have been shown to experience higher psychological distress (Nerrière et al., 2009; Van Houtte et al., 2012) and increased work pressure (Thomas, Kooijman, Cremers, & De Jong, 2006). Gassull et al. (2010) reported greater reactivity to stress in teachers and trainee teachers with voice problems. Interestingly, in the present study, stress was not linked with social emotional domain of V-RQOL which may suggest that it is more related to voice functioning. This is somewhat in line with the findings of Rantala and colleagues (2012) who found no association between stress and the VHI Emotional domain. Furthermore, as the vast majority of teachers with voice problems are women, it is important to consider the contribution of gender differences in the vocal health of women in vocally demanding careers. Women are more likely than

men to report higher stress, anxiety and depression (Dietrich et al., 2008), and stress and depression are more commonly reported by individuals with hyperfunctional voice disorders (e.g., muscle tension dysphonia). Hunter, Tanner, and Smith (2011) have also raised important gender distinctions that could make women more vulnerable to developing voice problems; for example, laryngeal and hormonal differences, pain sensitivity, respiratory and digestive systems differences, whole body hydration, and stress, anxiety and depression.

Personality may also play an important role in voice disorders (Baker, Ben-Tovim, Butcher, Esterman, & McLaughlin, 2013; Roy & Bless, 2000; Roy et al., 2000a) however, very few previous studies have investigated personality characteristics and voice problems in the teaching population. In the current study, increased scores for extraversion were linked to higher V-RQOL scores. Openness to experience was associated with reduced odds for frequency of voice problems, while agreeableness was associated with more voice symptoms. The effect of openness to experience is difficult to explain; perhaps this is related to extraversion and has its effect on voice in this way. More agreeable people may take on more responsibilities, and perhaps these teachers are more likely to have less general rest, increased stress levels and vocal load, and consequently be at greater risk for voice problems. Extraverts tend to be dominant, active and sociable (Roy, 2011). They may also be more vocally active and therefore at risk for functional voice disorders. In previous studies introversion was more often present in individuals with functional voice disorders while extroversion was characteristic of people with vocal nodules (Roy et al., 2000a). This is not consistent with the current effect of extroversion being associated with better V-RQOL scores. This may reflect more general reports in the literature of better self-reported quality of life in extroverts (Bowling & Windsor, 2001). Very few studies have investigated personality characteristics and voice problems in the teaching population. This is an area that warrants further research in order to better inform voice education programmes.

Higher self-efficacy scores were associated with fewer voice symptoms. Self-efficacy is strongly related to health-related behaviors (Bandura, 1977). General self-efficacy is defined as “one’s belief in one’s overall competence to effect requisite performances across

a wide variety of achievement situations” (Eden, 2001, para. 2) or as the individual’s “perception of their ability to perform across a variety of different situations” (Judge, Erez, & Bono, 1998, p. 170). Based on social cognitive theory, teachers’ self-efficacy may be conceptualized as teachers’ beliefs in their own ability to plan, organize, and carry out activities that are required to attain given educational goals” (Skaalvik & Skaalvik, 2010, p. 1059). Teachers with better self-efficacy may have a more active coping style when facing difficulties with their voices and/or the general demands of teaching, and therefore be less stressed. This is consistent with previous research demonstrating that teachers with voice problems perceived less control (e.g., over their time at work and the type of tasks assigned) and influence over their work compared to their peers with no voice problems (Alvear, Martínez, et al., 2010).

The way in which individuals cope with stress has been linked with voice problems, with coping proposed as playing a causal role and/or being a consequence of voice problems (Epstein & Hirani, 2011; Oliveira, Hirani, Epstein, Yazigi, & Behlau, 2012). In the current study, job satisfaction and the use of an avoidance coping style were associated with better voice quality ratings. Teachers who were satisfied with their jobs were more likely to have lower levels of distress, which may contribute to better voice quality. Similarly, teachers who tended to use more avoidance coping styles may have been less stressed, which may contribute to a better vocal quality. However this seems to contradict other studies reporting that people with voice disorders tended to use emotion-focused strategies (Deary, Wilson, Carding, & Mackenzie, 2003a; Mc Hugh-Munier, Scherer, Lehmann, & Scherer, 1997) in response to problems. It is important to point out the coping scale used in the current study did not pertain specifically to coping with dysphonia, but to coping with specific stress situations. It is therefore important to be cautious in interpreting this finding and in comparing this result with those from other studies. Van Wijck-Warnaar et al. (2010) found that teachers with high voice handicap index (VHI) had lower scores on ‘active confrontation or dealing with the problem’, and were higher on ‘passive reaction pattern’, compared to teachers with low voice handicap; while for the general population, individuals with high VHI scores were

higher on 'avoidance/waiting' and 'passive reaction pattern' than those with low VHI. Recently, Zambom et al. (2014) found that teachers with vocal complaints used more coping strategies, especially problem-solving, with higher scores observed for teachers who sought voice therapy. The same study found that a higher perception of limitation and restriction of participating in vocal activities was correlated with greater use of coping strategies, but coping was not associated with voice symptoms (Zambon, Moreti, & Behlau, 2014).

Teachers who experienced throat infection/laryngitis (especially >2 episodes in a year) were more likely to report more frequent and severe voice problems and symptoms. This finding is consistent with previous epidemiological and clinical studies (Ohlsson et al., 2012; Roy, Merrill, Thibeault, Parsa, et al., 2004). An unexpected result was the association between higher smoking pack years and less severe voice problems. A possible explanation is that a low number of sampled teachers had smoked or were current smokers and that these data are unreliable for this reason, however, Van Houtte et al. (2012) reported similar findings. It is possible that smokers downgraded their perceived voice problems because they are aware that their smoking could contribute to their voice problems. More detailed investigation of teachers who smoke is needed to better understand this finding.

A potential limitation of this research is that self-report measures were used to determine the presence of reflux, other medical conditions, and voice use behaviors as well as several other dependent and independent variables. The reliability and validity of many of these self-report measures had been demonstrated in previous research, but this was not the case for all measures. Further research to establish the psychometric properties of the non-standardized self-report questionnaire items is required.

Conclusions

The current findings have confirmed the association between a number of personal, vocal loading, environmental, and psychosocial factors and voice problems and voice-related quality of life, through a series of comprehensive multivariate analyses. Further research is needed to better elucidate some of the findings such as the openness to experience, coping

style, and smoking. An important consideration for future work examining voice education and training is that many of the factors associated with poor voice outcomes identified in the current study are modifiable, especially those with strong contributions to all models, such as reflux symptoms and voice use patterns. Other factors that were associated with poor voice outcomes such as noise in the room, stress, voice rest periods, voice training/education, use of chemicals in teaching, and throat infections/laryngitis can be managed by teachers themselves and/or their school management teams. Training could be more focused (i.e. intensive) for teachers with high risk of voice problems, however all teachers should receive training as a preventative measure. This study highlighted the need for broader assessment of risk for voice disorders in teachers and trainee teachers to ensure they are aware of these risks and can address factors that can be modified to ensure they have a healthy and effective voice throughout their teaching career.

Chapter 4: Vocal load among primary and secondary teachers with and without self-reported voice problems

Introduction

Vocal load has been identified as an important contributing factor for voice problems in occupational voice users (Vilkman, 2004), probably due to effects of long-term accumulated vibration exposure in the vocal fold tissue or dysregulated perilaryngeal muscle tension and posture (Morrison & Rammage, 1994; Švec et al., 2003; I. R. Titze et al., 2007; I. R. Titze et al., 2003; Vilkman, 2004). Vocal load has been defined as “the demands placed on the voice mechanism by the way a voice is used and how much it is used” (Hunter & Titze, 2010, p 862; Vilkman, 2004). Recent studies have sought a better understanding of the relationship between vocal load and occupational voice use by using long-term voice use monitoring (Åhlander et al., 2014; Bottalico & Astolfi, 2012; Bottalico, Pavese, Astolfi, & Hunter, 2014; Cantarella et al., 2014; Hunter & Titze, 2010; Mehta, Zaňartu, et al., 2012; Morrow & Connor, 2011; Portela et al., 2013; Remacle et al., 2014; Södersten, Salomão, McAllister, & Ternström, 2015; I. R. Titze et al., 2007; Van Stan et al., 2015), however, establishing healthy safe limits of voice use is still a challenge (Epstein, Portela, & Hirani, 2013; I. R. Titze & Hunter, 2013). Teachers are a group with high vocal demands and greater risk for the development of voice disorders; hence attempts have been made to understand how they use their voices at work and outside of work (Hunter & Titze, 2010; Portela et al., 2013; Remacle et al., 2014; I. R. Titze et al., 2007) and how vocal load and other factors may lead to a vocal problem in this occupational group (Åhlander et al., 2014).

Common chronic or recurring voice disorders such as those seen in teachers may result from overuse, inappropriate or abusive vocal behavior patterns or demanding voice use after inadequate recovery time, by exposing the larynx to repeated vocal fold posturing or excessive tissue vibration (i.e. vocal loading) (Hillman et al., 1989; Hunter & Titze, 2009). Everyday voice use is associated with temporary changes or damage (sometimes referred as phonotrauma) (Hillman et al., 1989; Hunter & Titze, 2009; Mehta, Zaňartu, et al., 2012; Mehta et al., 2013) to the vocal fold cover and consequently there is constant repair occurring (Hunter & Titze, 2009). Vocal misuse/abusive or overuse may also contribute to

changes in the laryngeal and other phonation-related muscles and respiratory muscle function, which may lead to symptoms such as loss of pitch and loudness control, voice breaks (due to increased effort to produce or maintain phonation), neck muscle tension, soreness and throat discomfort (Hunter & Titze, 2009; Roy, 2008; Van Houtte et al., 2010). These structural and functional changes are commonly seen in occupations with high vocal demands such as teaching where prolonged daily voice use is required (Van Houtte et al., 2010). Vocal load associated with voice problems is still assessed primarily through clinical measures, either in the clinic or during daily activities. Several authors have suggested that vocal load is better assessed during daily activities through long-term voice use monitoring (Hillman, 1989; 2013). Voice use parameters such as F0 and SPL, for instance, are higher when measured during daily activities than in laboratory conditions (Rantala et al., 1998; Södersten et al., 2002).

Higher F0 indicates a greater number of vocal fold collisions per second (Hunter & Titze, 2010; Roy, Merrill, Thibeault, Gray, et al., 2004; I. R. Titze et al., 2007; Vilkmán, 2004). Women experience more collisions per day than men, given the same time dose, which may explain, at least in part, why women experience more vocal fatigue (Hunter & Titze, 2010) and vocal injuries (Roy, Merrill, Thibeault, Gray, et al., 2004). Similarly, high voice SPL would lead to greater vocal fold sheer stress (Hunter & Titze, 2010).

Voice accumulators and voice dosimeters have been developed to quantify vocal load during daily activities (Cheyne et al., 2003; Ohlsson, Brink, & Lofqvist, 1989; Popolo et al., 2005; Švec et al., 2003; Szabo, Hammarberg, Hakansson, & Sodersten, 2001). Vocal load has been previously investigated by analyzing the acoustic signal from audio-recordings of voice samples (Jonsdottir, Laukkanen, & Vilkmán, 2002; Rantala et al., 1998; Rantala et al., 2002; Södersten et al., 2002; Szabo, Hammarberg, Granqvist, & Södersten, 2003), however voice dosimeters are now recognized as a more ecologically valid way to measure vocal load as they permit voice monitoring during daily activities for long periods of time (Szabo, Hammarberg, Hakansson, et al., 2001), with no interference from noise in the environment (Popolo et al., 2005). Modern voice dosimeters include the Ambulatory

Phonation Monitor (APM; KayPentax, Lincoln Park, NJ), NCVS (National Center for Voice and Speech) voice dosimeter (Salt Lake City, UT), VoxLog (Sonvox AB, Umeå, Sweden), and VocaLog (Griffin Laboratories, Temecula, CA). These dosimeters calculate phonation time (time dose), fundamental frequency (F0), sound pressure level (dB SPL) of the voice, and derived vocal dose measures such as cycle dose (number of vocal fold oscillatory cycles per specific time) and distance dose (distance the vocal folds travel per unit time; this measure incorporates cycles, intensity, and duration) (I. R. Titze et al., 2003), and background noise levels (when the speaker is not phonating). Studies are being conducted using new, low-cost clinical tools that include additional measures based on estimates of subglottal airflow extracted from the accelerometer signal to better identify and differentiate vocal patterns associated with voice hyperfunctional disorders and to improve diagnosis and treatment of behaviorally-based voice disorders (Mehta, Paul, & Hillman, 2012; Mehta, Zañartu, et al., 2012; Van Stan et al., 2015). Considerable research attention has been given to the impact of excessive vocal load on the larynx and voice function, and determining a healthy safe vocal dose level. Overall, however, it is still unclear how vocal load parameters are linked to vocal injuries or problems and hence further research is needed.

Long-term voice monitoring studies have shown that teachers phonate more than the general population (11%) during their working day (Watanabe, 1987) and more than other professionals such as speech pathologists (6.8%), nurses (5.4%), and office workers (7%) (Masuda et al., 1993; Ohlsson et al., 1989). Teachers vocalize twice as much when they are working compared to non-work hours (Hunter & Titze, 2010; I. R. Titze et al., 2007). Teachers' occupational percentage phonation times vary from 12% to 29.9% across studies (Bottalico & Astolfi, 2012; Hunter & Titze, 2010; Portela et al., 2013; Södersten et al., 2002). The variation across studies may be related to differences in voice monitoring methods, activities, teaching level and subject, and dosimeter specifications.

Reported phonation times vary across teaching levels and studies, with values ranging from 17% to 21.4% for preschool/kindergarten teachers (Masuda et al., 1993; Remacle et al., 2014; Södersten et al., 2002); and 16% to 25.9% for primary/elementary

teachers (Bottalico & Astolfi, 2012; Morrow & Connor, 2011; Remacle et al., 2014). Other variations in voice use between teaching levels have been reported. F0 daily averages for female teachers range from 226 to 268 Hz during occupational use and F0 values are slightly higher for preschool (247 to 266 Hz) than primary teachers (236 to 240 Hz). In studies using the APM, voice levels range from 77.2 to 82.9 dB SPL, and are slightly louder for kindergarten teachers (81.7 dB) (Remacle et al., 2014) and elementary music teachers (82.9 dB) (Morrow & Connor, 2011) than for regular elementary teachers, indicating some variation across teaching levels and subjects. Distance and cycle dose have been reported to be larger for preschool (Remacle et al., 2014) and primary music teachers (Morrow & Connor, 2011) when compared to primary classroom teachers; suggesting higher vocal load in preschool and primary music teachers. Vocal monitoring studies have either not included secondary teachers or have not reported findings separately for different teaching levels and so it is not known whether vocal loading differs between secondary teachers and those who teach younger children.

Changes in F0 and voice intensity have been proposed as signs of vocal loading (Laukkanen et al., 2008; Laukkanen & Kankare, 2006; Remacle, Finck, Roche, & Morsomme, 2012; Södersten, Ternstrom, & Bohman, 2005). In general, acoustic analysis (Laukkanen et al., 2008; Laukkanen & Kankare, 2006), and voice dosimeter (Hunter & Titze, 2010; Nacci et al., 2013) studies report a rise in F0 over the working day or with loading in laboratory-based experiments. Changes in voice SPL are not consistent across studies; some reports have shown a rise (Nacci et al., 2013) while no significant changes were found by others (Hunter & Titze, 2010). Inspection of voice changes across the day may help our understanding of voice use and indicate how teachers use their voice differently to compensate for vocal difficulties such as fatigue. Few studies, however, have continuously tracked voice variations across the teaching day and outside of work (Hunter & Titze, 2010); most have reported overall averages for the monitored time (Åhlander et al., 2014; Morrow & Connor, 2011; Portela et al., 2013; Remacle et al., 2014) and/or across teaching activities (Åhlander et al., 2014; Portela et al., 2013).

Higher F0 indicates a greater number of vocal fold collisions per second (Hunter & Titze, 2010; Roy, Merrill, Thibeault, Gray, et al., 2004; I. R. Titze et al., 2007; Vilkman, 2004). Women experience more collisions per day than men, given the same time dose, which may explain, at least in part, why women experience more vocal fatigue (Hunter & Titze, 2010) and vocal injuries (Roy, Merrill, Thibeault, Gray, et al., 2004). Similarly, high voice SPL would lead to greater vocal fold sheer stress (Hunter & Titze, 2010).

Researchers have monitored vocal load of teachers across teaching levels, teaching activities, and time of day, however, to date, only a few published studies have reported differences between teachers with and without self-reported voice problems using long-term monitoring. Åhlander et al. (2014) compared vocal load in teachers with and without self-assessed voice problems over one teaching day using the APM. The groups (12 females, 2 males in each group) differed in percent phonation time (time dose). Teachers with voice problems had greater phonation time during the total time at work and showed a negative correlation between F0 and voice SPL. For females only, teachers with voice problems spoke more quietly during the workday and had higher cycle doses. Nacci et al. (2013) monitored healthy teachers and teachers with vocal nodules (each $N = 5$) for five working days using the APM. Healthy teachers' F0 (average, mode) and vocal intensity increased progressively over the day, while teachers with vocal nodules showed a decrease in F0 (average, mode) and vocal intensity. Phonation time and distance dose did not differ significantly between groups.

Poor acoustical properties of the teaching environment and high background noise increase vocal demands (Vilkman, 2004). The teaching environment has been considered in several studies investigating the association between acoustics of the environment and teachers' vocal behaviour (Bottalico & Astolfi, 2012; Brunskog et al., 2009; Kob et al., 2008; Kristiansen et al., 2014; Pelegrín-García, Brunskog, Lyberg-Åhlander, & Löfqvist, 2012; Pelegrín-García, Smits, Brunskog, & Jeong, 2011; Sato & Bradley, 2008), but differences in research aims and methodologies make it difficult to synthesise findings across these studies. Brunskog et al. (2009) found differences in teachers' self-reported voice comfort

between rooms and a correlation between teachers' voice power and room volume and gain. Kob et al. (2008) compared teachers' vocal performance in rooms with 'poor' and 'good' acoustics and found that teachers with voice problems were more affected by unfavourable room acoustics (longer reverberation time, more noise) than vocally healthy peers. Pellegrín-García et al. (2011, p.1989) noted an increase in teachers' voicing periods during speech in "the most uncomfortable rooms to speak in". High classroom noise levels are associated with increased teachers' voice levels (Sato & Bradley, 2008; Bottalico & Astolfi, 2012; Kristiansen et al., 2014).

Kristiansen et al. (2014) found a significant correlation between changes in vocal symptoms over the workday and average noise exposure during teaching. Sato and Bradley (2008) found that excessive noise levels were a more relevant problem than poor room acoustics in the classrooms they measured due to the challenge of being able to achieve an adequate signal-noise ratio for teaching in a noisy room (ANSI standard). When room acoustics are poor, students may lose concentration and have reduced understanding of teachers' spoken information (Botallico & Astolfi, 2012). Poor acoustic support reduces voice performance and increases vocal effort needed to convey the message to students (Kob et al., 2008), hence it is important to examine the teaching environment alongside changes in the teacher's voice. The impact of the environment on voice and changes in noise levels over the teaching day has not been widely considered, however. The current study addresses this gap in the literature by measuring vocal load parameters and noise dosimetry (environmental noise levels) and changes over teaching day in teachers with and without voice problems.

In order to better understand vocal load in teachers with voice problems and the impact of the teaching environment, the current study addressed the following questions: 1) Are there differences in vocal load parameters between teachers with and without self-reported voice problems, and between primary and secondary teachers, 2) Are there differences in environmental noise levels and acoustic parameters of classrooms (reverberation time, room absorption) of teachers with and without self-reported voice

problems, and primary and secondary teachers?, 3) Are there changes in voice measures over the course of the teaching day for voice problem and control groups and both teaching levels, and 4) Are there associations between teachers' vocal load and voice self-ratings and the speaking environment over the teaching day?

Method

The current observational study used a case-control design to compare vocal load in teachers with and without self-reported voice problems, and primary and secondary teachers. The study was approved by the Human Participants Ethics Committee of The University of Auckland (2010/340; 2012/6755).

Participants

Primary and secondary classroom teachers were invited to participate in the study. About half (53%, 15 with voice problems and one control) of the teachers were recruited from participants in a previous survey of teachers' voices (Leão et al., 2015) who had indicated their interest in participating in further research. In the earlier study, teachers were asked *“during the past year, how often did you have a problem with your voice which prevented you from doing all you wanted to with it?”* (Leão et al., 2015). Teachers who reported voice problems more frequently than every couple of months during the past 12 months were recruited for the voice problem group (VP). For each teacher with a self-reported voice problem, a 'control' teacher (CON), with no self-reported voice problems, matched by gender, age, ethnicity, teaching level, and approximate teaching hours per week was recruited. The majority of CON teachers were recruited directly from the schools of the VP teachers. Smoking, neurological conditions, and previous larynx and neck surgery were exclusion criteria for both CON and VP groups. Three CON teachers were excluded because impaired voice quality, pitch or loudness was detected by the first author. One participant was a hearing aid user and another participant had unilateral hearing loss. In total, 30 classroom school teachers participated in the study, all with New Zealand European

(pakehā) or European ethnicity. The VP group ($N = 16$) comprised 13 females and 3 males with a mean age of 44 years (SD 11.6, range 26 - 63 years). Nine of the VP group were primary teachers and seven were secondary teachers. The CON group ($N = 14$) consisted of 11 females and three males with a mean age of 47 years (SD 12.8, range 27 - 65 years). Six were primary teachers and eight were secondary teachers.

Voice and Classroom Assessments

The following assessments were conducted during two typical teaching days at school over a period of several weeks for each teacher: 1) vocal load during the teaching day, 2) classroom noise dosimetry during the teaching day, 3) acoustic analysis of voice pre and post teaching day, 4) voice self-rating questionnaire pre and post teaching day. In addition, each teacher had a clinical larynx assessment and classroom dimensions and reverberation times were assessed. The two typical teaching days were chosen by the teacher. For this study, the term 'teaching day' refers to the regular period that teachers are in the school, excluding meetings or other activities at the start and end of the typical school day. All data collection and measurements were conducted by the first author. The larynx assessment was performed by a senior otolaryngologist with the assistance of a speech-language therapist.

Vocal Load Parameters

Continuous measures of vocal use during two typical teaching days were obtained using the Ambulatory Phonation Monitor (APM, model 3200, v1.05, KayPENTAX, Lincoln Park, New Jersey, USA) (Cheyne et al., 2003; Hillman et al., 2006), the only vocal dosimeter commercially available at the start of the study. The APM uses a miniature accelerometer (throat sensor) (model BU7135, Knowles Corp., Itasca, IL, USA) attached to the teacher's neck connected by a cable to a portable hardware module (microprocessor) placed in a waist bag. The APM permits the evaluation of the vocal load during daily activities over several hours and calculates phonation time (in seconds and percentage of voicing during the recording time: percent phonation time or time dose), F_0 (Hz), vocal intensity (dB SPL),

and derived measures such as cycle dose and distance dose. Švec et al. (2003, p.182) defined cycle dose as “the total number of oscillatory periods completed by the vocal folds over time” (which depends on F0 and phonation time), and distance dose as “the total distance accumulated by the vocal folds in a cyclic path during vibration”. Distance dose incorporates F0, intensity, and phonation time (Švec et al., 2003). The APM stores and displays data every 50 milliseconds. The default frequency and intensity ranges for the APM software are from 50 to 450 Hz for F0 and from 50 to 150 dB SPL.

Before the start of the regular school day (typically between 7.20 and 8.30 a.m.), the APM was positioned on the teacher. The APM throat sensor/transducer which is within a silicone pad was attached to the teacher’s neck with soluble glue, just above the sternal notch. Micropore tape was used to fix the silicone pad’s sensor and cable on the neck and body to avoid it moving. Prior to starting APM data collection, a calibration was performed to ensure the accuracy of accelerometer level captured from the skin in comparison with the SPL levels captured by the reference microphone 15 cm from the mouth. The calibration procedure followed the instructions described in the APM manual where teachers sustained the vowel /a/ from the softest level and gradually increased to the loudest level they could reach. On the software display, calibration is successfully completed when the regression line with sufficient data points shows the best linear correlation between skin accelerometer level (SAL) versus dB SPL. After calibration, the APM microprocessor was placed in the waist bag. Teachers were instructed to use their voice as they normally do during a typical teaching day. The APM was removed at the end of the school day (typically between 3.20 and 4.30 p.m.), according to each teacher’s schedule. At the end of each day, the APM data were downloaded using the APM software on Microsoft® Excel© (2010) as the raw data were used to calculate derived measures (Table 8) and different time analyses. The APM’s calibration, positioning and removal were performed by the first author for all research participants.

Noise Dosimetry

Environmental noise levels were measured using a micro noise dosimeter (CEL-350 dBadge; Casella CEL Inc., Buffalo, NY, USA). Immediately after the APM was attached and calibrated, the noise dosimeter was also calibrated using the standard acoustic calibrator (CEL-120/2; Casella CEL Inc., Buffalo, NY, USA). The noise dosimeter was then locked and attached to the teacher's shoulder on the side opposite the hand the teacher used to write on the board. Pin mounted clips were used to attach the dosimeter so that the microphone did not contact the teacher's clothing. Teachers with long hair were asked to tie their hair back and the teacher was instructed to not touch or move the device and to instruct their students not to touch, shout, or blow on the noise dosimeter. The dosimeter displays and stores ISO 9612:2009 parameters (International Standards Organization, 2009), including LAeq (time average sound level) and LCpeak (peak noise levels), each minute and overall across the recording duration. The dosimeter linear operating range is 65 to 140 and 95 to 143 dB SPL for LAeq and LCpeak, respectively. At the end of the day, the data were downloaded using the dBadge Casella software on Microsoft® Excel© (2010) sheets for analysis.

Acoustic Voice Analysis

Teachers' voices were recorded twice per teaching day for later acoustic analysis. At the beginning of the school day, the voice recording was conducted prior to the APM and noise dosimeter calibration and attachment. At the end of the day, the voice recording was made after removing both devices. Recordings were performed in a quiet room, with the teacher and the researcher only, usually before the students arrived at school and after they left at the end of the day. The voice recording system comprised a headset condenser microphone (AKG C420; Harman International, Vienna, Austria), pre-amplifier (M-Audio® Mobile Pre USB Interface; Rhode Island, USA), a laptop computer (DELL Inspiron 1545), and Audacity 2.0.4 software (sampling rate 44.1 kHz, 16 bit). The microphone was placed at a distance of 6 cm from the corner of the participant's lips and volume was controlled on the M-Audio pre-amplifier using the Audacity vu-meter. Tasks included producing a sustained

vowel /a/ (two to three trials) for approximately 5 sec at a comfortable pitch and loudness level. For the acoustic analysis, the most stable vowel sample was selected, the first second of the voice samples was removed (due to voice instability) and the three subsequent seconds were analyzed. The acoustic analysis software TF32 (Wisconsin, Madison, USA) was used to derive fundamental frequency (F0), jitter (%), shimmer (%), and speech signal-to-noise ratio (SNR) measures.

Voice Self-rating

Before and after the teaching day, teachers rated 11 parameters of their voices using a 4-point Likert rating scale with a descriptor at each end of the scale. Voice parameters and scale response options were: overall voice (1 = *very poor* to 4 = *excellent*), voice quality (e.g. normal, hoarse, rough, strain, husky, weak) (1 = *very poor* to 4 = *excellent*), voice production (1 = *very easy* to 4 = *very difficult*), vocal effort (i.e. force needed to speak) (1 = *no effort at all* to 4 = *lots of effort*), throat discomfort (e.g. throat pain, dryness, lump in the throat, tightness, clearing throat/cough) (1 = *no discomfort at all* to 4 = *lots of discomfort*), throat tiredness (1 = *no tiredness at all* to 4 = *very tired*), voice power (e.g. loudness, projection) (1 = *very poor* to 4 = *excellent*), pitch level (1 = *perfectly normal* to 4 = *severely impaired* (too low or too high), pitch range (range from the lowest to highest pitch during speaking or singing) (1 = *very limited pitch range* to 4 = *excellent pitch range*), voice breaks or cracking (1 = *no voice breaks at all* to 4 = *a very large number of voice breaks*), breathing when speaking (1 = *perfectly normal* to 4 = *severely impaired*), and neck and shoulder tension (1 = *not tense at all* to 4 = *very tense*).

Classroom Measurements

Measurements of reverberation time (RT), room volume (V), and room absorption were made for each teacher's classroom. RT is an objective parameter that describes the echoic quality of the room. RT is the time taken for sound in a room to decay to 60 dB below its original value. Room volume ($V m^3$) was estimated as the floor area of the room multiplied

by the height, measured using a laser tape measure (Prexiso X2; Prexiso AG, Switzerland). Room absorption was obtained by calculating $0.16V/RT$. Room measurements were carried out in the unoccupied classroom with the first author, and occasionally the teacher, in the room. The room's doors and windows were closed, and a microphone connected to a pre-amplifier and laptop computer was positioned in the middle of the room. The string was pulled on a party popper in each corner of the room to generate a noise stimulus for RT measurements. The recording system used was the same as that for voice recordings. The stimulus was recorded, saved in *wav* Format, and analyzed using the *dBati* software (01dB Metravib, Limonest, France). RT was based on average times for 500 and 1 kHz. Three teachers' rooms were not measured due to logistical difficulties.

Physiological Assessment of the Larynx

Teachers from both CON and VP groups underwent a larynx assessment carried out by an otolaryngologist mainly to exclude the presence of vocal fold pathologies in the CON group. A flexible endoscope (Olympus Visera, OTV-S7, Olympus Co., Tokyo, Japan) and video stroboscopy system (Rhino-Laryngeal Stroboscopy, KayPENTAX RLS 9100B, Lincoln Park, NJ, US) were used. Only one teacher (from the CON group) did not attend the otolaryngology appointment; this teacher did not report voice complaints and presented with 'normal' voice quality on voice screening. No frank mucosal pathologies or neurological impairments were diagnosed in the teachers in either the CON or VP group. A potential limitation of the study is that the diagnosis was not confirmed by a panel of experts so the possibility of mild oedema or inflammation cannot be excluded.

Vocal Load Data Processing

Three time analyses were undertaken for the APM and noise dosimetry to determine results over the teaching day: average daily analysis (overall day), three equal periods at the start, middle, and end of the day (T1, T2, and T3), and minute-by-minute analyses. APM raw data were used for the vocal load analysis in order to obtain derived measures (see Table 8) and synchronise APM data with noise dosimetry measurements for more detailed analyses.

Data were analysed for each teacher, with the duration of the school day varying from 6.05 to 7.00 hours. In order to analyse voicing periods, values outside the APM default range were removed (default range F0: 50 to 450 Hz, and SPL: 50 to 150 dB). APM and noise dosimetry data were processed in Microsoft® Excel® (2010). Data were cross-checked by a second person and the main APM measures computed in Excel were verified against APM software results. The APM captures data every 50 milliseconds and the noise dosimeter stores data in 1 minute time periods (ratio of 1200:1 data points for APM: noise dosimeter). In order to synchronise the APM data with noise dosimeter data for minute-by-minute analyses, the APM data were averaged across 1200 points per minute (1200 x 50 ms = 1 min), for the time period between 9:00 and 14:30 for all teachers.

Statistical Analysis

IBM SPSS Statistics v.22 software (Armonk, NY) was used for statistical analyses. Data were screened for errors, outliers, and missing values. Separate analyses were conducted for female and male data. Statistical analyses were conducted for the female data only ($N = 24$) due to the small number of male participants ($N = 6$; 3 per group) and the wide variation in the male data (Figure 6). Data from the APM, noise dosimeter, acoustic voice analysis, and classroom measurements were normally distributed (as demonstrated via Shapiro-Wilk, skewness and kurtosis analyses), hence parametric statistical tests were used. Non-parametric tests were used for voice self-rating variables due to the ordinal nature of the rating scale.

For comparisons between days 1 and 2 (D1, D2), paired t-tests were conducted for the APM (x 15 parameters), noise dosimeter (x 8 measures), and voice acoustics (x 4), and Wilcoxon Signed-ranks tests were used to compare voice self-rating data. Measures are presented in Tables 8, 9, and 10. The significance level was set at .05. Bonferroni corrections were used for multiple comparisons. Cronbach's alpha was used to evaluate the reliability of the voice self-rating scale. None of the measures differed significantly between the two days and hence averaged D1 and D2 data were included in subsequent analyses.

Analyses of variance (ANOVA) were conducted to examine group (x 2) and teaching level (x 2) effects on overall data for the teaching day for the APM measures. Repeated measures ANOVAs with group (x 2; VP and CON) and teaching level (x 2; primary and secondary) as between-subject factors and time period during the teaching day (x 3; start: T1, middle: T2, end: T3) as a within-subject factor were conducted for the APM and noise dosimeter measures. Voice acoustics were measured at the start and end of the teaching day. These results were also analyzed using repeated measures ANOVAs (group x 2, teaching level x 2, time x 2 / 2 groups X 2 teaching levels X 2 time points) for the acoustic measures. For voice (APM) and noise dosimetry, minute-by-minute analysis (comparisons of phonation time, SPL, F0, LAeq, and LCpeak), Mann Whitney U tests were used to compare VP and CON groups.

Greenhouse-Geisser corrected degrees of freedom and p values are reported when Mauchly's Test of Sphericity was significant (indicating non-homogeneity of variance) (Field, 2013). For parametric analyses, partial eta squared values (η_p^2) effect sizes are reported and for non-parametric analyses, r values (effect size 'r' - z / square root of N) are reported.

Mann Whitney U tests were used to compare groups for teachers' self-ratings and the classroom measurements (RT and room absorption). Associations between group APM and noise dosimeter measures for minute-by-minute analyses were examined using Pearson's correlations. Spearman correlations were used to examine associations between voice self-ratings and APM measures, and voice self-ratings and acoustic measures.

Results

In total, approximately 511 hours of APM recordings were collected. After processing, and excluding times outside the regular school day, final data analyses were based on 481 hours of school time. Results are presented as follows: 1) overall day analysis, 2) three periods of the school day, 3) noise dosimetry, 4) minute-by-minute data from APM and environmental noise dosimetry, 5) pre and post teaching day acoustic voice analyses, 6) pre and post teaching day voice-self ratings, and 7) correlations between APM and voice self-

ratings, 8) correlations between voice acoustics and voice self-ratings, and 9) room acoustics.

Vocal load analysis (APM measures): Overall day

A series of ANOVAs was conducted to determine whether there were differences in vocal load parameters between groups and teaching levels. Overall results, averaged across the two teaching days, for the 15 APM measures are shown in Table 8. Of the 15 APM measures, only phonation time differed by group and teaching level. Female teachers' phonation time (%) averaged across the teaching day ranged from 14.6% to 27.7%. The ANOVA results revealed a significant group by teaching level interaction effect for phonation time [$F(1, 20) = 8.335, p = .009, \eta_p^2 = 0.294$] (see Figure 6). Primary school teachers ($M = 23.4, SD = 3.6$) had significantly higher phonation times than secondary teachers ($M = 17.0, SD = 2.7$) for the VP group ($p = .004$). In addition, the VP group had significantly higher phonation times than controls ($M = 18.9, SD = 4.3$) for primary teachers ($p = .030$), while for secondary teachers ($M = 20.7, SD = 2.7$) there was no difference between VP and CON groups. Figure 6 illustrates this interaction between VP and CON groups and teaching level for phonation time.

Table 8

Means and Standard Deviations for Vocal Load Measures over the Teaching Day According to Group and Teaching Level for Females and Males

Measure	Females								Males					
	CON				VP				CON			VP		
	Primary M	SD	Secondary M	SD	Primary M	SD	Secondary M	SD	Primary M	Secondary M	SD	Primary M	Secondary M	SD
Phonation Time (%)	18.9	(4.3)	20.7	2.7	23.4	3.6	17.0	2.7	17.3	24.2	0.7	11.3	19.2	2.9
SPL Mean (dB)	79.1	3.0	81.0	4.2	79.2	5.2	78.6	5.7	70.7	78.8	1.3	76.8	80.1	1.5
SPL Median (dB)	79.5	2.9	81.4	4.7	79.7	5.8	79.3	5.9	70.5	80.3	2.5	76.5	80.8	2.5
SPL Mode (dB)	81.5	4.0	84.0	6.3	80.2	7.0	81.7	8.3	70.5	81.0	4.9	78.5	80.3	7.4
SPL SD (dB)	13.0	2.3	13.4	1.2	12.8	1.7	12.0	1.6	11.5	11.5	1.4	15.2	12.7	2.7
SPL cv (dB)	16.4	2.5	16.5	0.8	16.1	1.7	15.3	1.1	16.3	14.6	2.0	19.8	15.8	3.6
SPL Min (dB)	50.8	0.4	50.6	0.4	50.9	0.6	50.6	0.4	50.0	50.3	0.4	50.5	51.0	0.7
SPL Max (dB)	119.8	7.0	123.3	3.1	120.2	7.0	113.4	7.5	119.5	114.5	7.8	125.5	121.5	6.4
F0 Mean (Hz)	243.3	3.5	232.2	42.6	237.2	17.8	229.1	31.4	145.5	136.6	7.6	146.4	134.5	4.5
F0 Median (Hz)	230.3	5.4	222.7	44.7	227.9	17.0	217.3	25.0	135.0	129.0	9.2	139.0	127.0	6.4
F0 Mode (Hz)	232.9	16.6	230.1	60.3	237.2	18.1	217.7	29.3	117.5	112.8	25.1	119.5	121.8	6.7
F0 SD (Hz)	68.2	4.4	63.0	11.9	64.2	5.8	60.6	12.0	42.1	39.3	0.3	41.5	30.8	1.3
F0 cv (Hz)	28.0	2.0	27.1	1.9	27.2	2.7	26.3	2.2	28.9	28.8	1.4	28.3	22.9	0.2
F0 Min (Hz)	60.7	0.8	60.5	0.4	60.1	0.2	60.5	0.6	60.0	60.0	0.0	60.0	60.5	0.0
F0 Max (Hz)	495.9	0.9	496.4	1.8	495.6	1.5	494.8	2.1	493.0	487.5	1.4	484.5	490.0	4.9
Cycle Dose (k cycles)	1007	220	1074	307	1237	269	1541	140	561	617	375	371	558	131
Distance Dose (km)	3.2	0.5	4.1	1.9	4.2	1.8	3.0	1.3	2.0	3.1	0.7	1.9	3.1	0.1

Note: Females: CON (n=5 primary, n=6 secondary) and VP (n=8 primary, n=5 secondary), males: CON (n=1 primary, n=2 secondary) and VP (n=1 primary, n=2 secondary). SPL SD= SPL standard deviation (dB); F0 SD= standard deviation of fundamental frequency (Hz); SPL cv = SPL coefficient of variation; F0 cv = coefficient variation of fundamental frequency (cv = Mean divided by SD); SPL Min = minimum dB SPL; F0 Min = minimum F0 (Hz) ; SPL Max = maximum dB SPL; F0 Max = maximum F0 (Hz); Cycle dose showed in k cycles. There is no SD for male primary teachers of CON and VP groups as n=1.

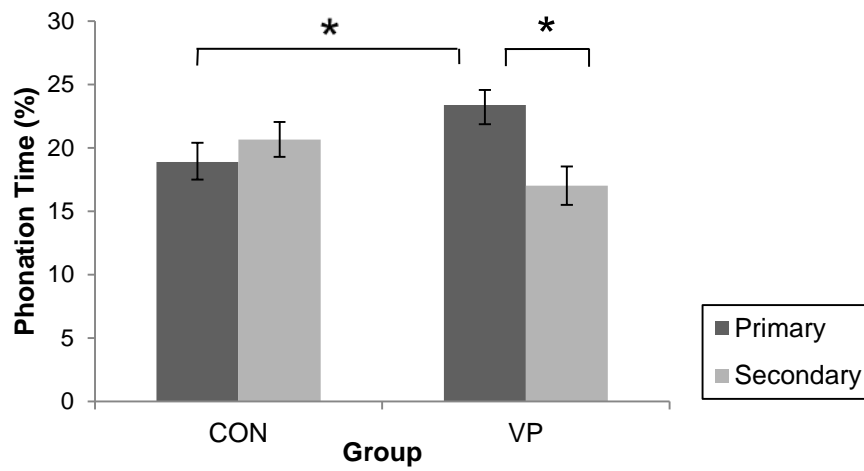


Figure 6. Comparison between voice problem (VP) and control (CON) teachers according to teaching level for phonation time percentage (time dose). Phonation time showed a significant interaction effect for group and teaching level. Error bars represent standard errors of the mean. *p < .05.

APM analysis: Changes over the teaching day (three time periods)

Within-subject analyses showed significant changes over the three time periods of the teaching day for phonation time [$F(1.5, 30) = 6.071, p=.011, \eta_p^2 = 0.233$], F0 mean [$F(1.5, 30) = 4.663, p = .026, \eta_p^2 = 0.189$], and F0 min [$F(2, 40) = 5.448, p = 0.008, \eta_p^2 = 0.214$]. Over the teaching day, phonation time dropped (particularly at the end of the day), while F0 increased gradually over the three periods. F0 min was lower in the middle of the day. Table 9 shows the APM values across the three time periods for the female teachers.

Between-subjects analysis revealed a group effect only for F0 min [$F(1, 20) = 4.769, p=.041, \eta_p^2 = 0.193$] and F0 max [$F(1, 20) = 5.305, p=.032, \eta_p^2 = 0.210$]; these effects were not apparent when the data were examined overall across the whole teaching day. F0 min (CON $M = 61.5$ Hz, $SD = 0.75$; VP $M = 60.8$ Hz, $SD = 0.77$) and F0 max (CON $M = 494.6$ Hz, $SD = 1.94$; VP $M = 492.8$ Hz, $SD = 1.99$) were both lower for the VP group. As was seen for the overall day analysis, there was a group by teaching level interaction effect for phonation time when the three time periods were analyzed [$F(1,20) = 8.510, p=.009, \eta_p^2 = 0.298$] (see Table 9). For the CON group, primary and secondary teachers had similar phonation times, however for the VP group phonation times were higher for primary teachers. For secondary teachers phonation times were similar for teachers with and without voice problems, as was seen for the overall day analysis.

Male data (phonation time, SPL mean, and F0 mean) are presented individually in Figure 7. The male teachers' pattern of change over the day varied between individuals. For phonation time (Figure 7A), there was a drop in the middle of the day (which includes lunch) compared to the beginning of the day for all VP males and one control (S29), while the beginning of the day yielded the lowest phonation time for the other two male controls (P21 and S23). Comparing T1 with T3 and excluding the middle of the day as it included the lunch break, all controls increased their voicing time at the end of the day, whilst the opposite pattern was found for VP teachers. This is different from the overall pattern for females, who had similar T1 and T2 percentages and a reduction in phonation time at the end of the day. Overall there were no changes in SPL over the teaching day for males. One teacher

(CON.S29) showed a slight drop in the middle of the teaching day compared to the beginning of the day and VP.P5 dropped his voice level in the middle of the day. Comparing T1 and T3 F0 values, most male teachers showed a similar pattern to female teachers, namely, a rise at the end of the day, with the exception of CON.S29 who had a reduction in F0 from the middle of the day (T2 and T3).

Table 9

Means and Standard Deviations for Vocal Load and Dosimetry Measures across the Three Time Periods (start-middle-end) of the Teaching Day for Females

Measure	Time 1		Time 2		Time 3	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
APM Measures						
Phonation Time (%)	21.5	6.1	21.5	3.6	18.4	4.9
SPL Mean (dB)	78.7	5.2	79.2	4.7	78.9	5.4
SPL Median (dB)	79.4	5.8	79.7	5.3	79.4	6.1
SPL Mode (dB)	81.1	7.0	80.5	6.9	80.6	8.2
SPL SD (dB)	12.4	1.7	12.6	1.9	12.4	1.7
SPL cv (dB)	6.5	0.7	6.4	0.7	6.5	0.6
SPL Min (dB)	50.7	0.5	50.7	0.5	50.7	0.5
SPL Max (dB)	117.0	7.6	118.1	7.5	117.7	7.6
F0 Mean (Hz)	227.2	29.6	233.6	26.8	238.0	27.3
F0 Median (Hz)	218.3	30.0	223.6	26.9	228.0	27.6
F0 Mode (Hz)	222.8	38.1	232.9	35.2	233.4	36.8
F0 SD (Hz)	61.1	8.3	62.4	8.5	63.2	9.9
F0 cv	3.8	0.3	3.8	0.3	3.8	0.3
Noise Dosimeter Measures						
LAeq Mean (dB SPL)	73.1	3.2	73.3	3.3	73.0	3.3
LAeq Median (dB SPL)	73.1	4.2	73.8	3.9	72.3*	4.4
LAeq SD (dB)	5.7	1.1	5.9	1.0	6.0	1.0
LAeq Min ¹ (dB SPL)	64.0	0.2	64.0	0.2	64.0	0.0
LAeq Max (dB SPL)	86.2	3.7	87.7	4.5	87.6	3.6
CPeak Mean (dB SPL)	102.5	2.7	102.8	2.8	102.6	2.8
CPeak Median (dB SPL)	101.9	3.3	102.2	3.4	101.9	3.5
CPeak SD (dB)	5.9	0.8	6.0	0.9	6.1	0.8
CPeak Min (dB SPL)	94.1	0.2	94.1	0.2	94.1	0.3
CPeak Max (dB SPL)	120.6	4.1	122.1	4.6	121.3	4.4

Note. Table shows combined data over the three periods of teaching day as there was no significant statistical difference between VP and CON groups, except for F0min and F0 max. ¹64 dB SPL is the lowest SPL that can be recorded by the noise dosimeter.

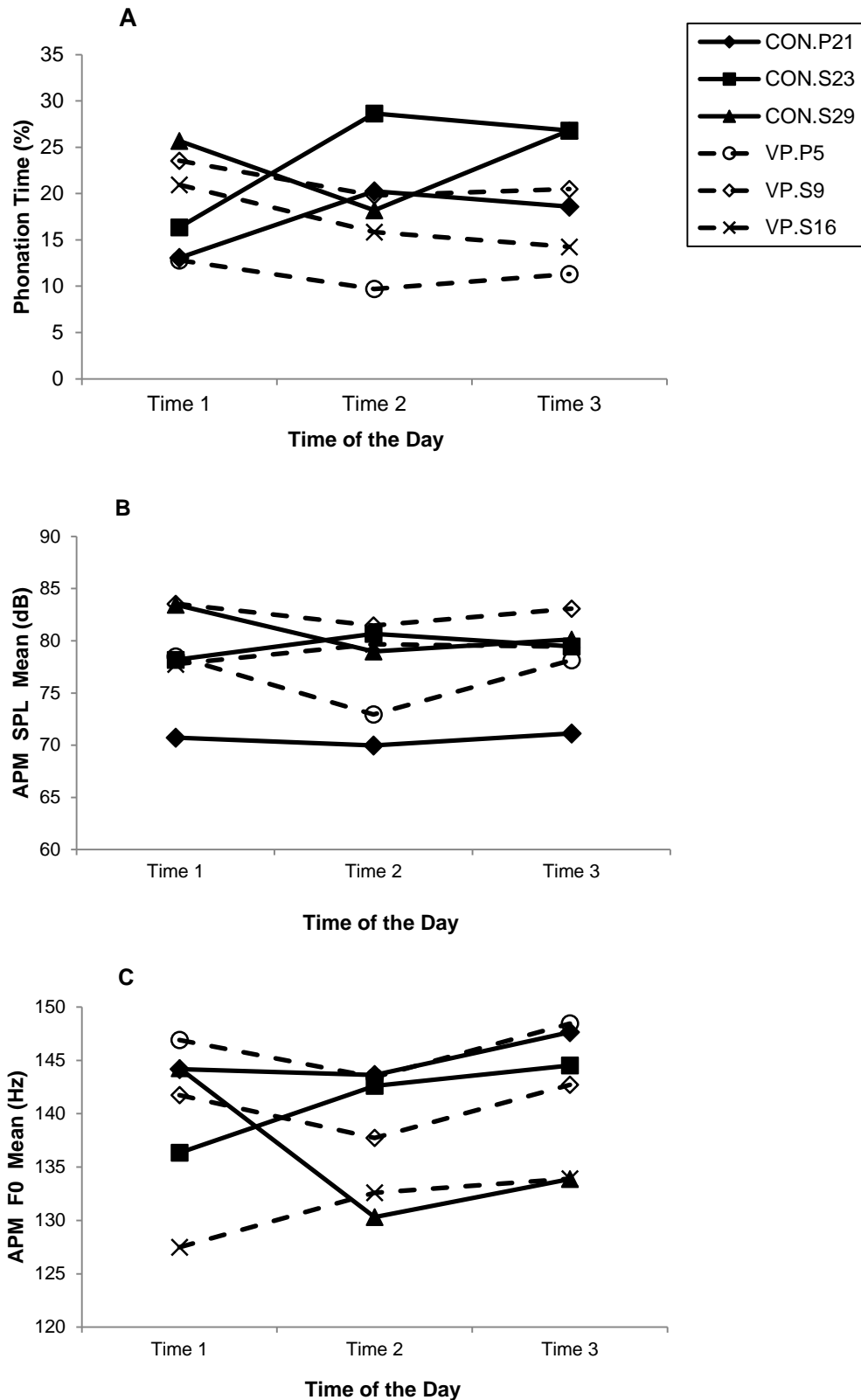


Figure 7. Mean phonation time (A), APM SPL (B), and APM F0 (C) for individual male teachers (N = 6) across the three time periods over the teaching day. CON = Control group, VP = Voice Problem group, P = Primary, and S = Secondary.

Noise dosimetry analysis: Overall day and three time periods

A series of ANOVAs was conducted to investigate differences in environmental noise levels within and between groups and teaching levels. For the overall teaching day, there were no significant differences between groups and teaching levels (Table 10). However, when the three time periods were analyzed, there was a significant time effect on LAeq median [$F(2, 40) = 4.940, p = .012, \eta_p^2 = 0.198$], LAeq max [$F(1.3, 25.9) = 3.964, p = .048, \eta_p^2 = .165$], and LCpeak max [$F(1.7, 26.5) = 6.719, p = .006, \eta_p^2 = .251$]. LAeq median dropped at the end of the day, while LAeq max and LCpeak max increased in the middle and the end of the day (Table 9). For males, based on the patterns shown in Figure 8, environmental noise levels (LAeq and CPeak medians) were slightly higher for CON teachers. Over the three time periods, patterns varied among teachers. Associations between overall day noise levels and vocal load (cycle and distance dose) were examined using correlation analysis. Distance dose was positively correlated with LAeq Median ($p = .008, r = .526$) and LAeq Mean ($p = .014, r = .495$), that is, larger distance dose was associated with increased noise levels.

Table 10

Means and Standard Deviations for Noise Dosimetry Measures (Environmental Noise Levels) over the Teaching Day for Females and Males

Measure	Females								Males					
	CON				VP				CON			VP		
	Primary (N=5)		Secondary (N=6)		Primary (N=8)		Secondary (N=5)		Primary (N=1)	Secondary (N=2)		Primary (N=1)	Secondary (N=2)	
	M	SD	M	SD	M	SD	M	SD	M	M	SD	M	M	SD
Noise Dosimeter Measures (dB)														
LAeq Mean	73.0	2.2	73.7	4.2	74.4	2.8	71.2	2.4	72.1	72.8	1.0	69.7	70.7	0.9
LAeq Median	73.5	2.7	74.0	4.8	74.8	3.4	70.5	3.7	72.8	73.8	0.5	67.5	69.0	3.4
LAeq SD	6.2	1.5	6.4	0.8	5.8	0.3	6.3	1.1	6.0	5.5	0.4	6.2	7.3	1.3
LAeq Min	64		64		64		64		64	64		64	64	
LAeq Max	91.4	5.9	89.0	4.8	90.3	3.0	87.2	3.2	88.5	86.0	1.6	89.4	93.1	8.0
LCpeak Mean	102.2	2.4	103.7	3.4	103.2	1.9	101.1	2.7	102.1	102.6	0.9	100.5	101.4	0.4
LCpeak Median	101.8	2.9	103.6	3.8	102.7	2.4	100.6	3.7	102.4	102.9	1.5	99.5	100.3	1.5
LCpeak SD	6.4	1.0	6.2	0.7	5.9	0.5	5.8	1.1	5.8	5.9	0.3	6.6	7.1	1.8
LCpeak Min	94		94		94		94		94	94		94	94	
LCpeak Max	124.9	3.8	123.1	3.4	124.2	3.7	119.8	3.0	122.8	121.6	7.2	129.1	128.6	4.2

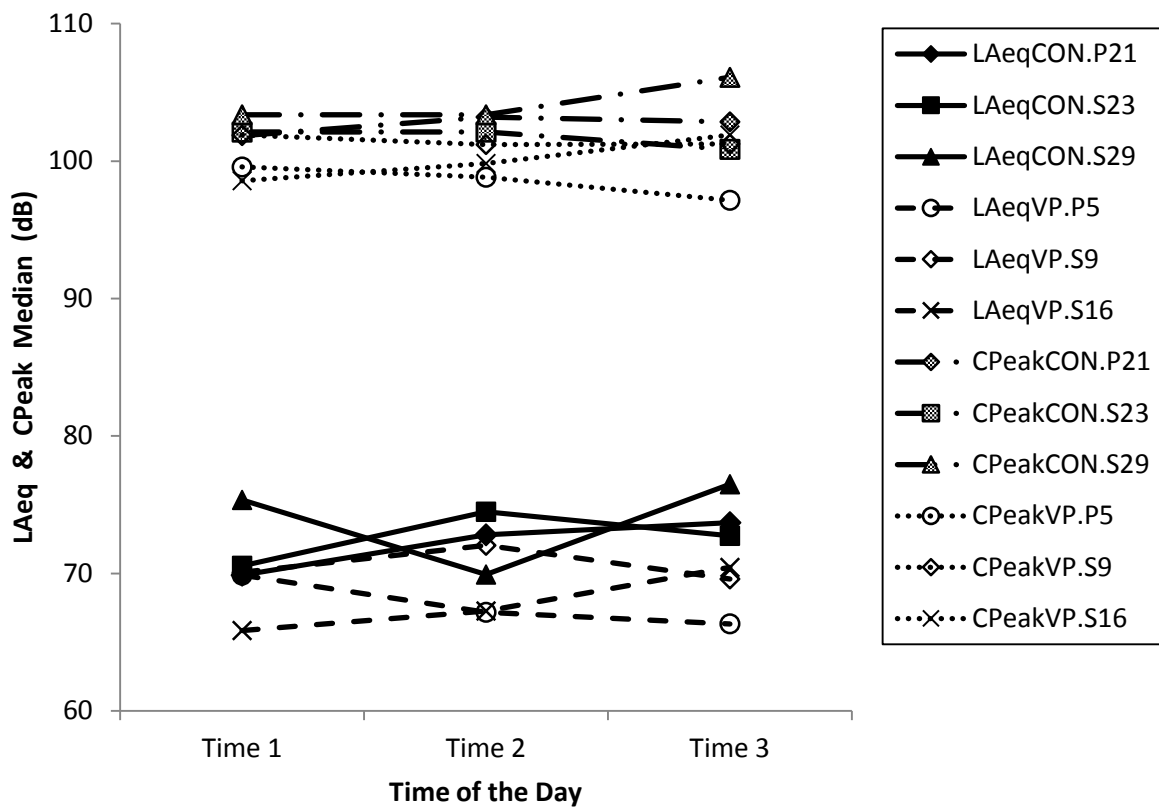


Figure 8. LAeq (dB) and LCpeak (dB) levels for individual male teachers (N = 6) across the three time periods of the teaching day. CON = Control group, VP = Voice Problem group, P = Primary, and S = Secondary.

Noise dosimetry and APM minute-by-minute analysis

More detailed minute-by-minute APM data (approximately 340 time points over the teaching day) were examined to determine whether there were patterns of change over the teaching day and to compare voice (APM) and environmental (noise dosimeter) sound levels for the female teachers. Individual APM data points (every 50 ms) were averaged across a minute (SPL mean, F0 mean, phonation time per minute) in order to synchronize these data with the noise dosimeter data (LAeq and LCpeak), which were recorded on a minute-by-minute basis. Variations in the voice measures are shown in Figure 9. Although Figure 9 shows considerable minute-by-minute variation in phonation time, voice levels, and F0, the range of values for each measure was relatively small.

A Mann Whitney U test was used to compare minute-by-minute data between CON and VP groups. Although the average differences were small, these were significant differences for three of the measures (see histograms in Figure 9). The CON group had higher median APM SPL (CON = 78 dB, VP = 76.8 dB), and LCpeak levels (CON = 102.9 dB, VP = 102.4 dB) than the VP group, ($U = 39817$, $z = -7.021$, $p < .001$, $r = 1.43$; $U = 45833$, $z = -4.672$, $p < .001$, $r = 0.95$, respectively). The VP group had slightly higher median phonation times than the CON group (CON = 20.5%, VP = 21.0%), $U = 51303$, $z = -2.537$, $p = .011$, $r = 0.5$).

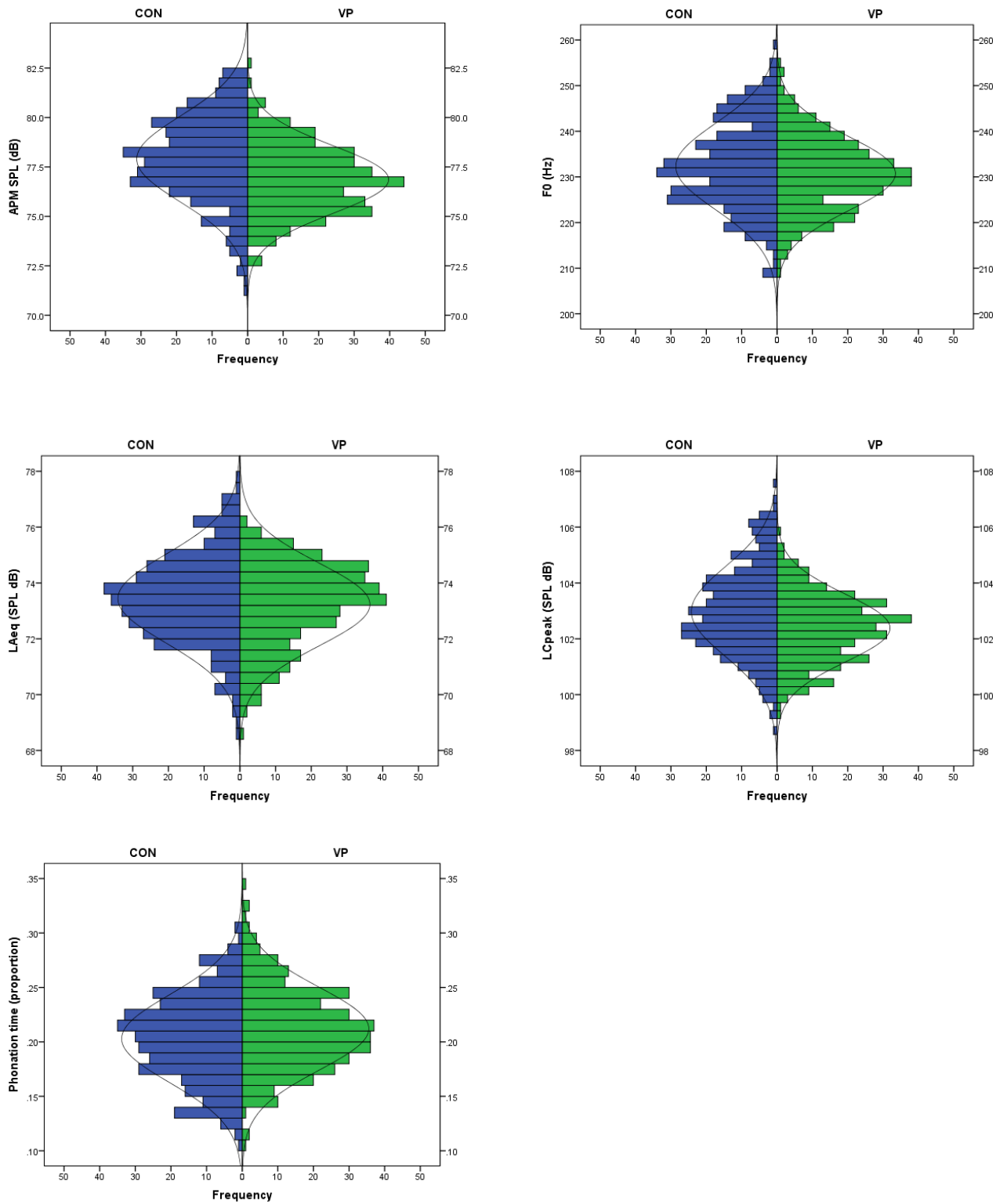


Figure 9. Histograms for APM SPL (dB), APM F0 (Hz), phonation time, LAeq (dB SPL), and LCpeak (dB SPL) for minute-by-minute data of female teachers for CON and VP groups.

Figure 10 shows more detailed changes over the day for the three groups based on the minute by minute analysis. Figure 10 shows that, in general, the VP group spoke more, with lower SPL than the CON group. The peak time for phonation time was in the middle of the day for both groups. The VP group's phonation times (per minute) were slightly higher than the CON group in the middle and at the end of the day (Figure 10A). The CON group had higher F0 and greater F0 range variation at the middle and end of the day compared to the VP group (Figure 10B). The CON group spoke louder on average than the VP group (especially in the middle of the day), with greater F0 and level variation over the teaching day (Figures 10B and 10C). Voice levels for the VP group decreased at the end of the day.

The relationship between voice and environmental sound pressure levels recorded using the noise dosimeter, minute-by-minute, is shown in Figure 11. Overall patterns are similar across groups, however higher voice levels (APM SPL) are noticeable for the CON group. Drops in peak levels are more evident around 120 and 240 minutes (approximately 2 and 4 hours after the start of the school day, which may be during break times). Peak sound levels in the environment are consistently high, at around 100-105 dB SPL. LAeq levels are consistently lower than APM SPL levels, indicating that the teacher's voice level at the microphone exceeded the ambient noise level measured via the dosimeter on the teacher's shoulder. Although this suggests a positive signal to noise ratio when comparing the teacher's voice to background noise in the classroom, this difference will in part be due to the A weighting of the classroom noise levels, which de-emphasizes low frequencies below 500 Hz whereas the APM uses linear weighting for dB SPL measurements.

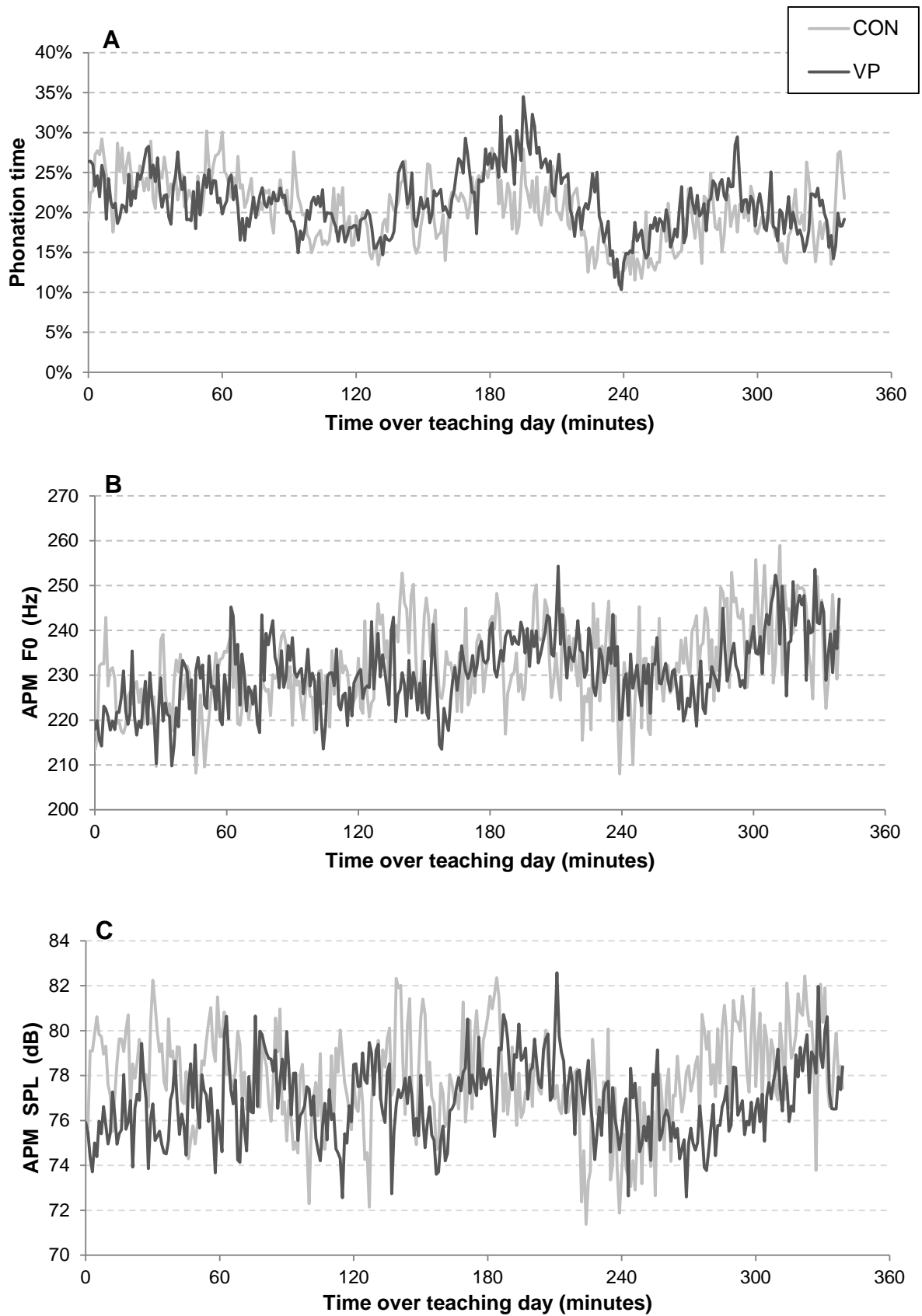


Figure 10. Minute-by-minute phonation time (%), APM F0, and APM SPL averaged across female teachers for CON (grey) and VP (black) over the teaching day. (0 min = 9.00 am; 360 min = 3.00 pm)

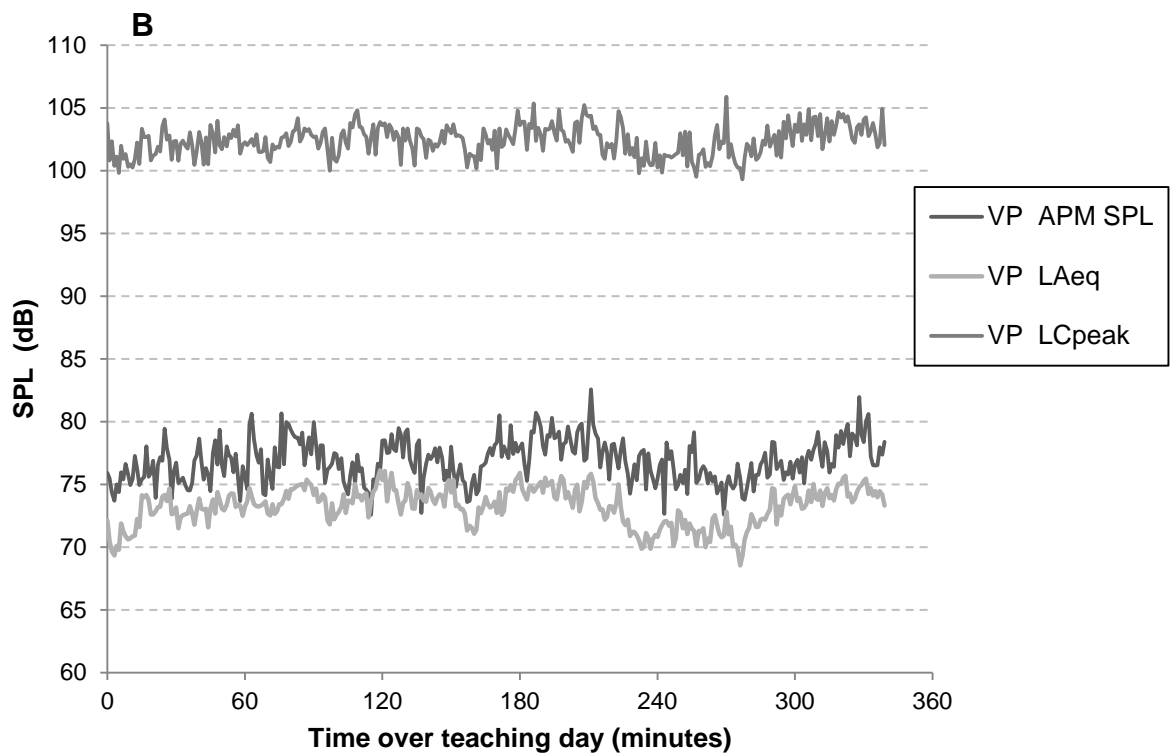
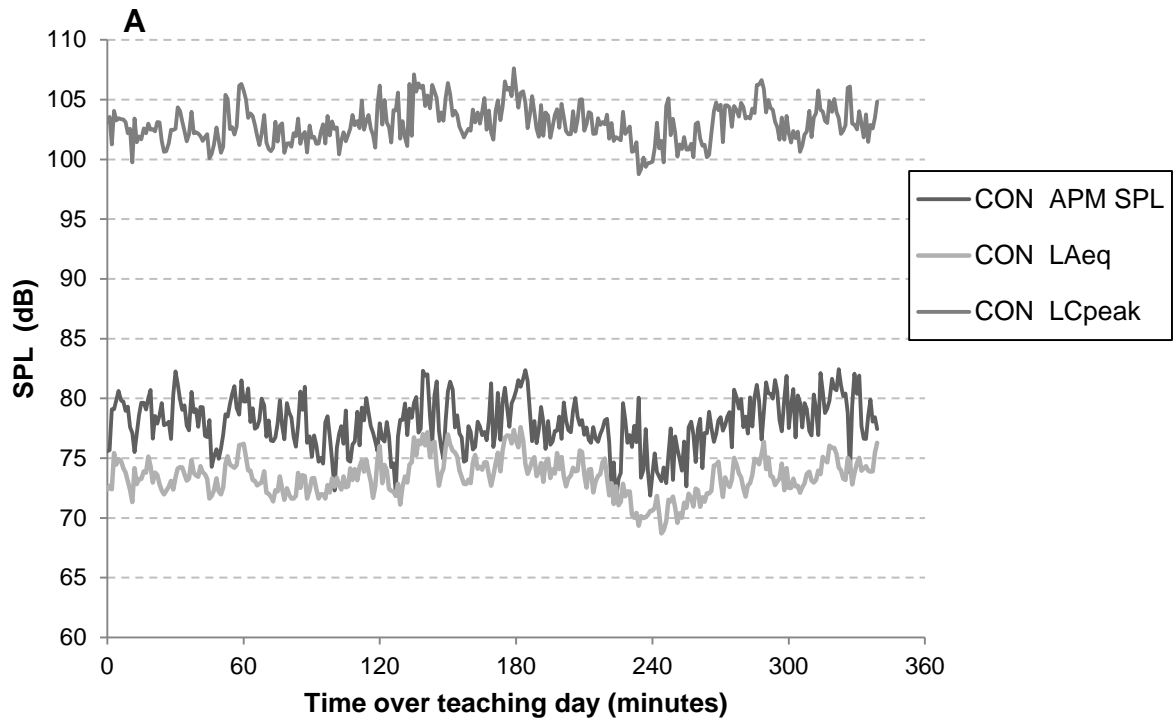


Figure 11. Voice levels (APM SPL dB; middle line) and environment levels [LAeq (bottom line); LCpeak (top line)] averaged across female teachers over the teaching day (minute-by-minute, from 9.00 am to 2.30 pm) for controls (CON) and the voice problem group (VP).

Pearson's correlations between minute-by-minute data averaged across participants for APM F0 and APM SPL measures revealed a positive correlation for both groups ($p < .001$). APM F0 increased with APM SPL levels (Figure 12). The CON group showed larger variation in F0 and SPL than the VP group. Positive correlations were also found between APM and noise dosimeter measures: LAeq and LCpeak versus APM F0 (Figure 13), LAeq and LCpeak versus APM SPL (Figure 14), and LAeq, LCpeak, and APM SPL vs vocalizations per minute (phonation time per minute) (Figure 15) ($p < .001$). The slopes of the linear regression lines (see regression equations on Figures) are similar between groups, but show an approximately 0.5 dB difference in APM SPL between the two groups (Figure 14). Figure 15 shows an association between teacher vocalisations measured with the APM and LAeq and LCpeak levels measured with the dosimeter. In general, higher vocalization rates are associated with higher sound levels in the environment. The slopes of the regression lines differ for VP and CON groups. The reduced slope for the VP group suggests that the vocal behaviour in varying classroom conditions of these teachers is different from CON teachers.

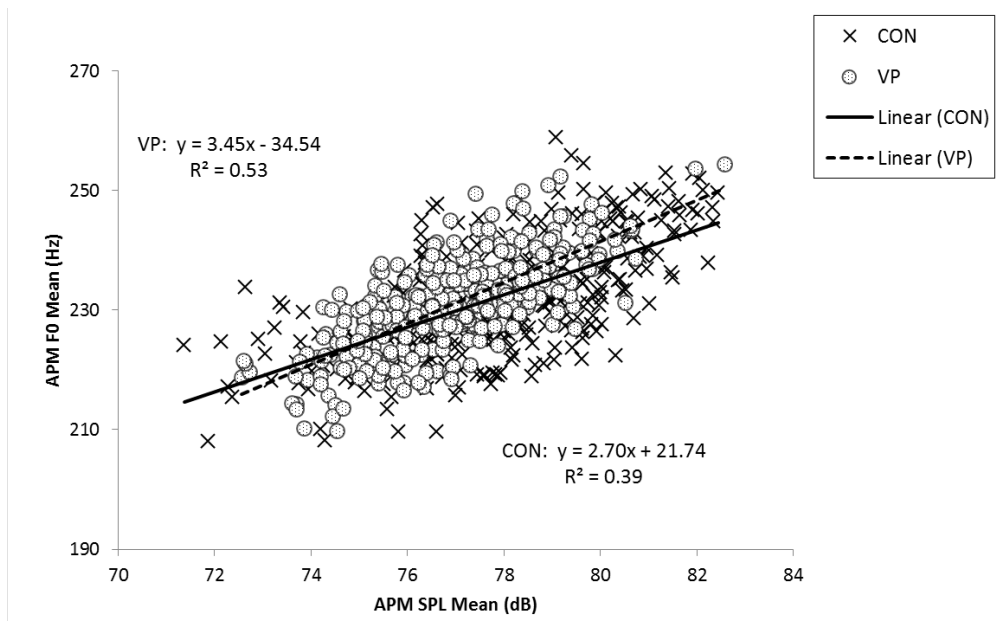


Figure 12. Correlation between APM SPL (dB) and APM F0 (Hz) for CON and VP groups, for the minute-by-minute data over the teaching day. The two lines indicate linear regression lines; $p < .001$ for both correlations.

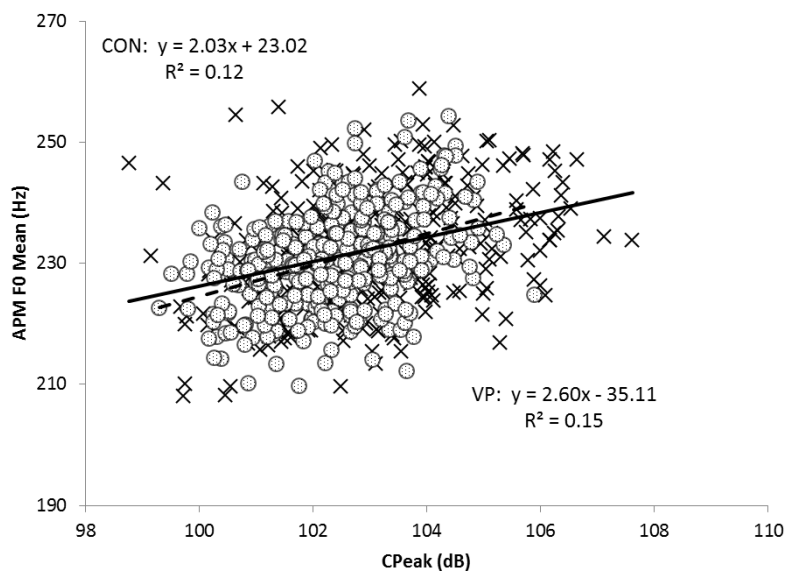
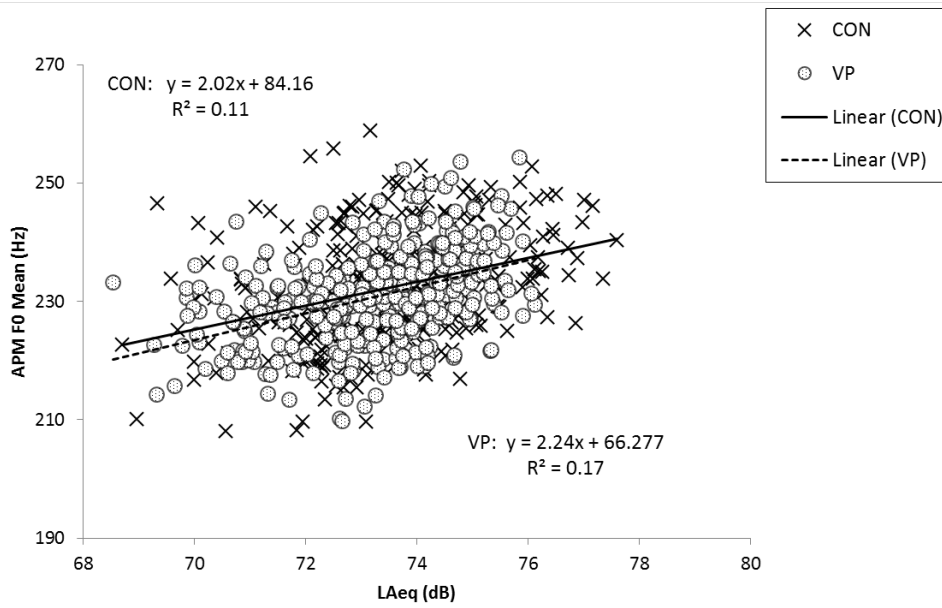


Figure 13. Correlation between noise dosimeter LAeq (dB) / LCpeak (dB) and APM F0 (Hz) for CON and VP groups, for minute-by-minute data over the teaching day. The two lines indicate regression lines; $p < .001$ for both correlations.

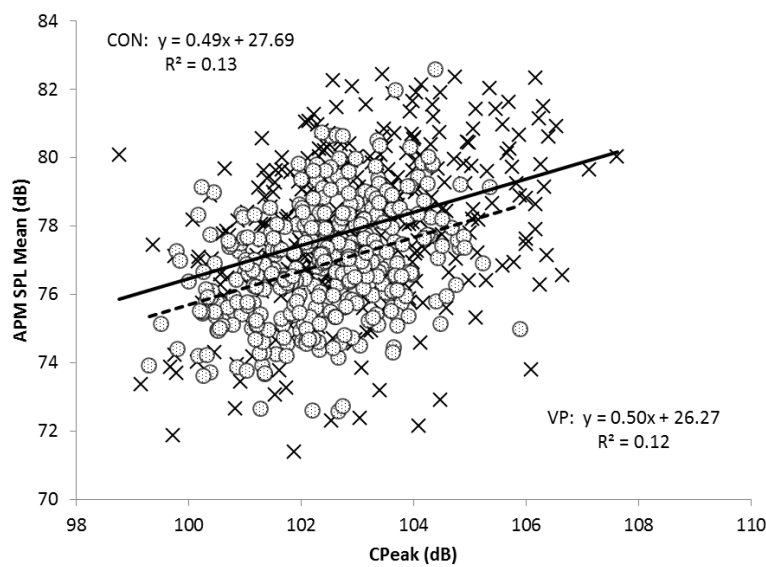
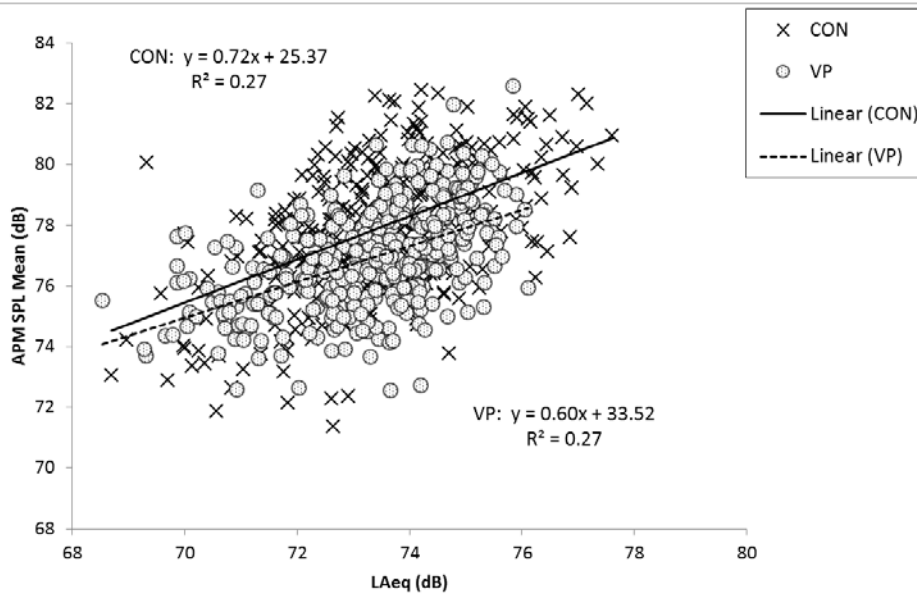


Figure 14. Correlation between noise dosimeter LAeq (dB) and voice SPL (dB), and LCpeak (dB) and voice SPL (dB) for CON and VP groups, for minute-by-minute data over the teaching day. The two lines indicate regression lines; $p < .001$ for both correlations.

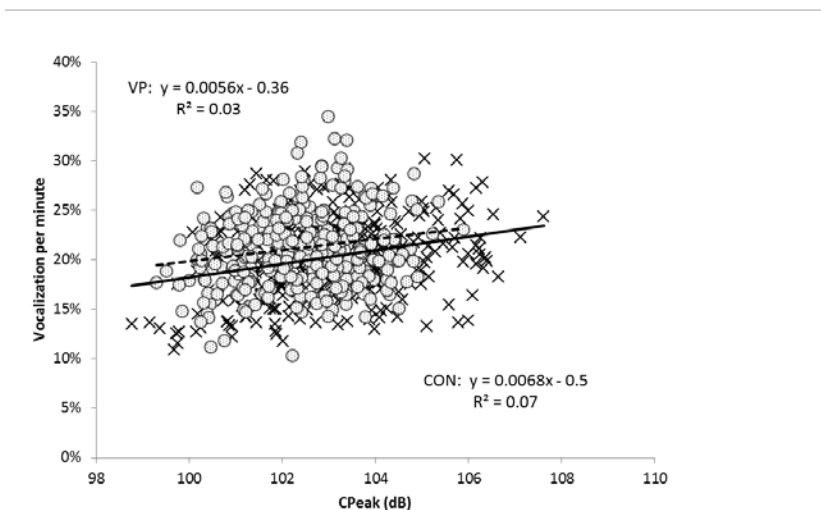
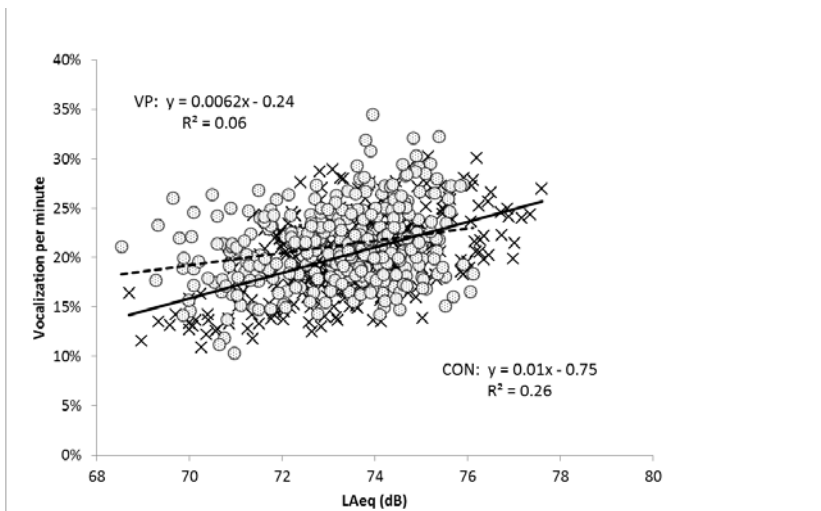
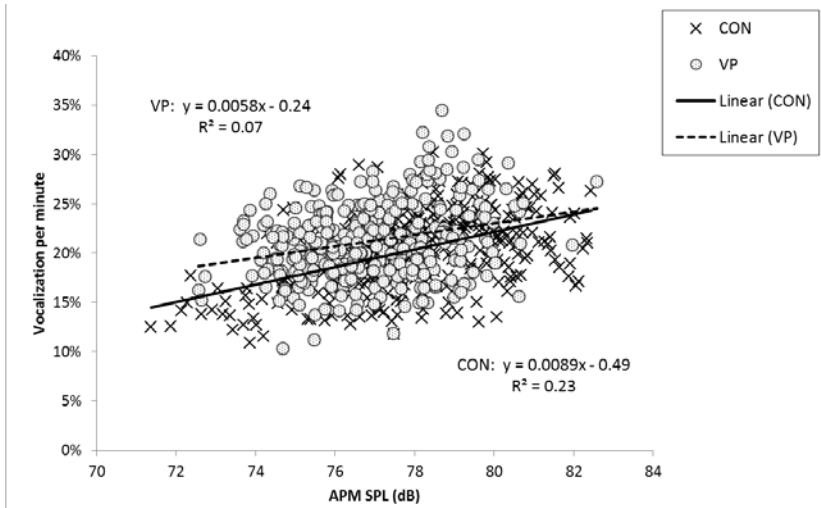


Figure 15. Correlation between noise dosimeter LAeq (dB) and LCpeak (dB A) and APM SPL (dB) vs vocalizations (%) per minute, for CON and VP groups, for minute-by-minute data over the teaching day. The two lines indicate regression lines; $p < .001$ for both correlations.

Group differences in acoustic environment (noise levels, room parameters)

Across the day no difference was found between groups for environmental noise levels. There was also no difference in room reverberation between VP and CON groups, consistent with Åhlander et al. (2014). Åhlander et al. recorded sound levels during teaching periods via a sound level meter placed in the APM waist bag. In contrast, the more detailed minute-by-minute analysis in the current study showed that environmental peak sound pressure levels were higher for CON than for VP teachers, by 0.5 dB on average. Higher peak levels (C-weighting) and equivalent LAeq levels suggests that the teaching environment of CON teachers has more high level, low frequency noise (e.g. chair noise). Higher peak levels suggest that the teaching environment may be more dynamic for CON teachers than for VP teachers.

Room acoustic properties did not differ between teachers with and without VP, however significant differences were observed in RTs and room absorption between primary and secondary teachers. All primary teachers had carpeted rooms, but few secondary teachers did. Although the average primary (0.45 sec) and secondary (0.65 sec) RTs in the current study exceeded the recommended value for children of 0.4 sec (Whitlock, 2008), there were no correlations between RT and sound absorption and APM measures. This lack of relationship could reflect the relatively small range of RTs (0.29 to 1.03 s) in the current study. Brunskog et al. (2009) also found that teachers' voice power levels and RT were not correlated. Similarly, Kristiansen et al. (2014) found that RT did not have an effect on voice levels or phonation time. Further study is needed.

Acoustic voice analysis: Pre vs post teaching

Acoustic data for the two times of day and two teaching levels are summarized in Table 11. A series of ANOVAs was conducted on the female data to examine differences in acoustic voice measures (F0, jitter, shimmer, SNR) between groups and teaching level across time of day (pre versus post). There was a significant time by teaching level interaction effect for F0 [$F(1, 20) = 5.014, p = .037, \eta_p^2 = 0.200$] and for SNR [$F(1, 20) =$

4.512, $p = .046$, $\eta_p^2 = 0.184$]. As shown as in Table 11, primary teachers had reduced F0 after the teaching day ($p = .032$), regardless of the self-reported voice status; there was no significant pre- versus post-difference for secondary teachers ($p = .891$). For SNR, secondary teachers had higher values after the teaching day ($p = .023$), whereas no significant changes were found for primary teachers ($p = .400$) (see Table 11). There was a statistical trend for a group effect on SNR [$F(1, 20) = 4.217$, $p = .053$, $\eta_p^2 = 0.174$]; overall, the CON group ($M = 26.6$, $SD = 3.25$) showed a trend for higher SNR than the VP group ($M = 23.8$, $SD = 3.32$).

Table 11

Means (Standard Deviations) of Acoustic Measures According to Time period (pre and post teaching day) and Teaching Level

Acoustic measure	PRE		POST	
	Primary	Secondary	Primary	Secondary
Females				
F0 (Hz)	193.8 (25.7)	185.0 (30.6)	185.5 (23.3)	185.4 (31.3)
Jitter (%)	0.7 (1)	0.4 (0.2)	0.6 (0.6)	0.3 (0.1)
Shimmer (%)	1.6 (1.3)	1.7 (1.1)	1.7 (0.8)	1.3 (0.4)
SNR	25.1 (3.8)	24.7 (3.7)	24.5 (3.7)	26.2 (3.1)
Males				
F0 (Hz)	121.7	107.6 (4.5)	118.6 (0.9)	114.7 (7.1)
Jitter (%)	0.3 (0.1)	0.5 (0.2)	0.3 (0.1)	0.4 (0.2)
Shimmer (%)	1.1 (0.5)	2.4 (0.6)	1.1 (0.5)	2.0 (1.2)
SNR	28 (4.5)	21.3 (3.6)	25.8 (2.4)	23.1 (4.3)

Note: Females - primary $n = 13$, secondary $n = 11$; Males - primary $n = 2$, secondary $n = 4$

Voice self-ratings: Pre vs post teaching

Wilcoxon Signed Rank and Mann Whitney U tests were used to compare voice self-ratings, pre and post teaching day, and between groups and teaching levels for female teachers. After Cronbach alpha reliability tests, two items (out of 12) with low item-total reliability (lower than .3) (Portney & Watkins, 1993) were removed from the voice self-rating scale: breathing difficulty when speaking and neck and shoulder tension. The final Cronbach's alpha for the voice self-rating scale responses pre teaching day was .931 and post teaching was .881.

Results from the Wilcoxon Signed Rank test revealed statistically significant differences in ratings between the start and end of the teaching day. Scores increased (a high score indicates worse symptoms) significantly for six voice parameters: voice overall ($z = -3.210, p = .001, r = .65$), voice quality ($z = -2.647, p = .008, r = .54$), ease of voice production ($z = -2.991, p = .003, r = .61$), throat discomfort ($z = -3.027, p = .002, r = .62$), vocal tiredness ($z = -3.120, p = .002, r = .64$), and voice power ($z = -1.964, p = .049, r = .40$), pitch changes ($z = -2.300, p = .021, r = .47$), and the total scale score ($z = -3.510, p < .001, r = .71$). Pre- versus post-ratings did not change for males.

Mann-Whitney U Tests showed significant differences between VP and CON groups but not between teaching levels for self-ratings ($p \geq .093$). For the ratings before the teaching day began, significant group differences were found for voice overall ($U = 34.500, z = -2.246, p = .025, r = .46$), voice quality ($U = 37.000, z = -2.046, p = .041, r = .42$), vocal effort ($U = 30.500, z = -2.472, p = .013, r = .50$), throat discomfort ($U = 25.000, z = -2.803, p = .005, r = .57$), and total score ($U = 32.000, z = -2.290, p = .022, r = .47$). Medians were higher for all parameters for the VP group (a high score is worse): voice overall, voice quality, vocal effort, throat discomfort, and total score. After the teaching day, ratings of vocal effort ($U = 36.500, z = -2.075, p = .041, r = .42$), throat discomfort ($U = 38.000, z = -2.087, p = .037, r = .43$), and voice power ($U = 36.000, z = -2.160, p = .031, r = .44$) revealed significant differences between groups, with worse ratings for VP teachers. Using Cohen's (1988) criteria for effect size, these differences indicate a moderate group effect (r values between .3 and .5).

Correlations between vocal load and voice self-ratings

To determine whether there was an association between APM measures (F0, SPL, phonation time) and voice self-ratings for the female teachers, Spearman correlations were carried out for the start and end of the day data. There were correlations between APM phonation time at time 1 (T1) and pre-teaching self-rated pitch range ($p = .002$, $r = .600$) and between F0cv at time 1 and pre-teaching throat discomfort ($p = .015$, $r = .492$). Lower APM SPL levels at time 3 (T3) were associated with higher (poorer) post-teaching ratings of voice overall ($p = .044$, $r = -.415$), throat discomfort ($p = .013$, $r = -.499$), and total voice self-rating scores ($p = .037$, $r = -.428$). At the end of the day phonation time in T3 was correlated with pitch changes ($p = .010$, $r = -.515$) and mean F0 was correlated with throat discomfort ($p = .013$, $r = -.499$). No other correlations were significant. If the significance value is corrected for multiple comparisons none of these associations are statistically significant.

Correlations between acoustic voice measures and voice self-ratings

Spearman correlations were also conducted to inspect associations between acoustic measures from the voice recordings and voice self-ratings, at the beginning and at the end of school day for the female teachers. For analyses before the start of school time, a higher SNR was associated with better voice quality ratings ($p = .02$, $r = -.471$). For the end of the school day, lower F0 was associated with poorer voice quality ratings ($p = .009$, $r = -.522$), and higher jitter was correlated with poorer voice overall ($p = .042$, $r = .419$).

Room acoustics

A series of ANOVAs was performed to determine whether there were differences in reverberation time and room absorption between groups and teaching levels, for the total group of male and female teachers. Overall, rooms for the VP group had longer reverberation times (CON = .53 s, VP = .57 s) and lower absorption (CON = 442 m³/s, VP = 409 m³/s) than CON group teaching rooms, however this difference was not statistically significant. Significant differences were found between teaching levels for reverberation time [$F(1, 22) = 9.728$, $p = .005$, $\eta_p^2 = 0.307$] and room absorption [$F(1, 22) = 7.587$, $p = .012$, $\eta_p^2 = 0.256$].

=kl 0.256]. Primary teachers' rooms had lower reverberation times (primary $M = .45$ s, $SD = .17$; secondary $M = .65$ s, $SD = .16$) and greater absorption (primary $M = 495$ m³/s, $SD = 118$; secondary $M = 356$ m³/s, $SD = 116$) than secondary teachers' rooms. Among correlations between room acoustics (RT, absorption) and APM measures, noise dosimetry, and voice self-ratings, only one association was found (RT vs APM SLPCv, Pearson's $r = -.423$, $p = .050$; lower reverberation time was associated with increased coefficient of variation of voice SPL, however this result is not significant after Bonferroni correction).

Discussion

The current study used a vocal dosimeter to investigate whether there were differences in vocal load between teachers in primary and secondary schools with and without voice problems and to determine whether there are distinct differences in patterns of voice use over the day. Few differences among vocal load parameters were found between VP and CON groups. In general, the VP group had higher phonation time percentage (particularly evident for primary teachers' overall day analysis), and they spoke more quietly than the CON group. Both groups of teachers increased F0 and decreased voicing time over the teaching day. There were positive correlations between F0 and voice SPL, and vocal load measures (F0, SPL, vocalizations per minute) and noise levels, for both groups. Noise dosimeter levels changed across the day; median LAeq decreased while maximum levels increased (LAeq max and CPeak max). Thus, speech levels decreased but noise levels in the teaching environment increased across the day. Greater noise dosimeter peak levels were found for the CON teachers. Primary teachers' rooms had better acoustics (lower reverberation and higher absorption) than secondary teachers' teaching spaces.

This study addressed four questions: a) group differences in vocal load; b) group differences in acoustic environment; c) changes over the teaching day; and d) associations between voice measures and environmental noise levels determined using noise dosimetry.

Group differences in vocal load

Teachers with voice problems had higher percentage phonation time (time dose) based on the minute-by-minute data. In the overall day analysis, percentage phonation time was the only parameter showing a significant difference between VP and CON groups, and this was only for primary teachers. The more detailed minute-by-minute analysis did not separately examine primary and secondary teachers, but also showed a difference in phonation time (and voice SPL) between VP and CON groups. This corroborates Åhlander and colleagues' (2014) findings from their APM study that did not separate groups based on teaching level; Åhlander et al. also showed higher phonation time for teachers with VPs during the working day. Teachers with voice problems may always have misused or overused their voice, i.e., they may have always phonated more than other teachers. VP teachers may also phonate more due to the need to repeat themselves and/or keep talking in order to have the children to follow what they are saying because their vocalizations are less effective in the teaching environment. This is consistent with evidence showing that teachers' dysphonia has a negative effect on students' learning (Lyberg-Åhlander, Brännström, et al., 2015; Morton & Watson, 2001; Rogerson & Dodd, 2005).

The finding that VP primary, but not secondary teachers, had higher overall phonation time in the overall day analysis is consistent with previous epidemiological reports that primary teachers are at higher risk than secondary teachers for developing a vocal problem (M. Angelillo et al., 2009; Leão et al., 2015; Ubillos et al., 2015), although other authors have not found a significant difference in risk between teaching levels (Kooijman et al., 2006). Secondary and primary teachers in the current study did not differ in their cycle or distance dose. Similarly, although phonation time (time dose) differentiated VP and CON groups in the overall day analysis, cycle and distance dose measures did not. This result differs from Åhlander et al. (2014) who did not report distance dose, but found significantly higher cycle dose in female teachers with VP compared to controls. Cycle dose depends on F0 and phonation time (Švec et al., 2003). Consistent with Åhlander et al. (2014), CON teachers had slightly higher F0 than VP teachers (this difference was not significant in either

study). Mean F0 values for females in the VP and CON groups (VP 233 Hz, CON 237 Hz) are comparable to those of Åhlander et al. (2014) (VP 234 Hz, healthy voice group [VH] 240 Hz).

Phonation time is relevant when studying vocal fatigue that leads to vocal fold injury. Hunter and Titze (2010) noted that assessing teachers' high phonation percentage during work facilitates understanding of potential vocal injuries due to the increased number of vocal fold collisions (Hunter & Titze, 2010). The amount, duration and distribution of voice rest periods are important for vocal fold recovery (I. R. Titze et al., 2007). High phonation time means less vocal rest, which may lead to voice problems and increase voice injury risk (Åhlander et al., 2014; Gaskill et al., 2012; I. R. Titze et al., 2007). Bottalico et al. assessed the distribution of voicing and silence periods (voice rests) in primary teachers during 'traditional' lessons. Teachers were divided into three groups: group 1 ($n = 3$) had vocal pathologies measured objectively (nodules, cyst), group 2 ($n = 11$) had self-reported vocal symptoms, and group 3 ($n = 11$) had no vocal symptoms (Bottalico et al., 2016; Bottalico, Pavese, Astolfi, Hunter, et al., 2014; Bottalico, Pavese, Astolfi, & Hunter, 2014). Teachers with vocal pathologies had higher overall accumulation of time dose than other groups. These teachers also had more silence periods (< 3.16 s) [suggesting different respiratory patterns/behaviors and larynx functioning, as stated by Bottalico et al (2016) and other reports in the literature (Gordon, Morton, & Simpson, 1978)] and fewer longer rest periods (≥ 3.16 s) [suggesting an inadequate fluid redistribution in the vocal fold tissue (Fisher et al. 2001), as pointed by Bottalico et al. (2016)]. Longer rest periods are important for short-term vocal recovery (Fisher, Telser, Phillips, & Yeates, 2001; Švec & Sram, 2001; I. R. Titze et al., 2007); inadequate recovery time may result in vocal pathology in teachers. Bottalico et al. (2016) argued that rest periods < 3.16 seconds may not have an observable effect on recovery time, and this could lead to vocal pathologies. VP and CON teachers in the current study are similar to Bottalico and colleagues' groups 2 and 3. Unlike the current study, Bottalico et al. found no difference in phonation time between their groups 2 and 3. The distribution of voicing and silence periods was not examined in the current study and did not

differ between groups 2 and 3 in Bottalico et al. (2014, 2016). The minimum number and duration of silence periods (voice rests) to experience any degree of tissue recovery is still unclear (Hunter & Titze, 2009; Titze & Hunter, 2007). The finding that teachers with VP had higher phonation times, however, suggests that voice breaks may need to be better managed or formally built into teachers' schedules as a preventive action.

In general, the present study confirms previous reports of percentage phonation times during teaching. Combining all groups of teachers, the NZ values for occupational phonation time from the current study (females $M = 20.5\%$, range 17.0 - 23.4%, males $M = 19.2\%$, range 11.3 - 24.2%) are lower than values reported by Hunter & Titze (2010) for American primary and secondary teachers in years K-12 (29.9% overall, females 30.7%, males 27.4%). Another U.S. study involving 31 teachers in years K-12, reported a mean voicing percentage of 23% (I. R. Titze et al., 2007). In the current study, primary teachers' phonation times (20.7% overall; females VP 23.4%, CON 18.9%) were similar to values reported by Masuda (1993) (U.S., 21.58%), Remacle et al. (2014) (France, $\approx 20\%$), Bottalico et al. (2012) (Italy, 25.5%), and Morrow & Connor (2011) (U.S., 16%). No previous studies have reported data separately for secondary teachers. Differences in phonation time across studies and between teachers are likely to reflect differences in teaching methods (e.g. co-teaching) between regions, types of school (e.g. area schools), time periods sampled, speaking situations (e.g. reading, talking), teaching styles (e.g. group or mat work, one-to-one, blackboard), and classroom activities (e.g. literacy, art).

Although VP teachers phonated longer, they spoke more quietly. Group differences were more evident for voice SPL for the detailed minute-by-minute data than for the overall day and start-middle-end of day analyses. The VP group was significantly quieter than the CON group. This finding is consistent with average workday analysis for female teachers reported by Åhlander et al. (2014). Similarly, Nacci et al. (2013) found a trend for five teachers with vocal nodules to have reduced SPL over the day in comparison with five healthy primary teachers. Rantala et al. (1999) used a different measurement approach (4-min voice recordings from three different times over the day), and found teachers with many

vocal complaints spoke more quietly than those with few complaints (N = 12 primary and secondary teachers), consistent with the current study and with Åhlander et al. (2014).

Teachers with self-reported VP may speak more quietly for physical and/or behavioral reasons (Rantala & Vilkmán, 1999). For instance, managing behaviour in the classroom may be more challenging for teachers with quiet voices. The VP teachers may have had more difficulty than CON teachers increasing/sustaining their voice levels under challenging teaching conditions (e.g. when it was noisy) due to the nature of their voice problem. Teachers may also avoid using a louder voice because it exacerbates the physical symptoms of effort, discomfort, fatigue or they could use a quieter voice to preserve their voice over the teaching day. This would be consistent with VP teachers' reports of greater effort, throat discomfort, and difficulty increasing voice power compared to CON teachers. Amplification may relieve these voice symptoms. The VP teachers in the current study did not have frank pathologies and hence their voice problems are likely to be associated with functional problems (e.g. muscle tension problems, temporary vocal folds tissue changes, overused or under-recovered voice). The majority of teachers teachers (Fritzell, 1996) and other occupational voice users presents clinically with functional voice disorders (Sułkowski & Kowalska, 2005; Van Houtte et al., 2010). Muscle tension based voice disorders could be multifactorial, reflecting vocal overuse, inappropriate pitch, intensity, and/or breath support, other psychosocial factors such as personality and stress, and organic factors such laryngopharyngeal reflux (Morrison & Rammage, 1993; Roy, 2003, 2008; Van Houtte, Van Lierde, et al., 2011). Muscle tension based voice problems are associated with increased vocal effort, throat discomfort, fatigue, restricted vocal flexibility, and vocal quality alteration which are likely to make it difficult for teachers to speak loudly. These difficulties may be more apparent in primary teachers who typically require more vocal flexibility to sing and speak in outdoor activities.

Speaking levels of 65 dB SPL and greater at 1 m indicate that teachers are using raised voice levels (as would be expected given the noise levels in teaching environment), rather than conversational levels (Olsen, 1998; Pearsons, Bennett, & Fidell, 1977). A level of

65 dB SPL equates to 77 dB SPL at 15 cm distance (the calibration distance for the APM). Average voice levels of female VP and CON teachers in the current study based on the APM measures were 79-81 dB SPL, louder than the teachers in Åhlander et al. (2014) whose voice levels were 70-74 dB SPL. Teachers' averages are in the range of healthy teachers (75-82 dB SPL) reported by Nacci et al. (2013) and Remacle et al. (2013) (79-80 dB SPL) for primary teachers measured using the APM and reported by Sato and Bradley (2008) based on sound level meter measurements (78.4 dBA SPL). Some of the variation in reported voice levels across studies likely reflects differences in recording method and mouth-microphone distance. APM studies use a 15 cm distance (Åhlander et al., 2014; Morrow & Connor, 2011; Nacci et al., 2013; Remacle et al., 2014), but others report sound pressure levels at 1 m (Bottalico & Astolfi, 2012) (a difference of 16.5 dB due to reduced sound pressure with distance).

No significant differences were found between groups and teaching levels for F0 measures. Overall, F0 values (mean, median and mode) (Table 8) are in the range reported in the literature for studies using vocal dosimeters for teachers during work time. Across teaching levels, the NZ findings for F0 in primary teachers ($M = 240$ Hz, $Md = 229$ Hz, Mode = 236 Hz) are identical to Italian teachers ($N = 36$; $M = 240$ Hz) (Bottalico & Astolfi, 2012), slightly higher than Americans ($N = 5$; $M = 236$ Hz, Mode = 207 Hz) (Morrow & Connor, 2011), and slightly lower than French primary teachers ($N = 20$; $M = 253$ Hz, Mode = 226 Hz) (Remacle et al., 2014). No dosimeter data has been reported for secondary teachers separately, and hence further study is needed. In the current study, values for secondary teachers ($M = 231$ Hz, $Md = 220$, Mode = 224) are within the range reported in the literature for teachers from different teaching levels ($Md = 226$ Hz, Mode = 194 Hz; Hunter & Titze, 2010).

Changes over the teaching day (vocal load, acoustic environment)

When the three periods of the teaching day (beginning, middle, end of day) were examined, VP and CON groups did not differ for most measures. No significant group and

teaching level differences were found for F0 and SPL. VP and CON teachers had similar vocal patterns over the day, significantly increased F0 and reduced phonation time over the teaching day, and no significant changes in voice SPL over the three periods of the day. Hunter and Titze (2010) similarly noted a slight increase in female teachers' F0 during the school day (with no reduction in SPL at the end of the day). Nacci et al. (2013) found similar patterns for a small cohort of healthy teachers, with an increase in F0 (but also for voice SPL) over the school day, while an opposite trend was shown by people with vocal nodules for F0 and voice SPL. The gradual rise in F0 over the day is evident in the minute-by-minute analysis (Figure 10B). The minute-by-minute analysis of voice levels (APM SPL, Figure 10C) shows reduced voice SPL at the end of the day for VP teachers compared to controls.

The decrease in phonation time at the end of the day suggests vocal fatigue and/or a change in teaching activities. In the current study teachers continued talking during the middle of the day, which included lunch time, thus limiting their opportunity for vocal rest (and therefore vocal fold tissue recovery). Based on acoustic analysis of voice recordings from the first and last lessons of the day in primary and secondary teachers (N= 33) with few versus many vocal complaints, Rantala et al. (2002) found a significant rise in F0 values over the day for the group as a whole and for those with few complaints, but not for the group with many vocal complaints. In their study singing and reading text samples were excluded due to influences on F0.

A trend for an increase of F0 with vocal load has been previously observed in teachers during the teaching day and in other occupational voice users based on acoustic measurements (Laukkanen & Kankare, 2006; Lehto et al., 2006; Rantala et al., 2002; Whitling, Rydell, & Åhlander, 2015). This rise in F0 with loading is hypothesised by Titze & Hunter (2015, p.23) "to be related to lack of muscle relaxation when the larynx remains primed all day for speech". Remacle et al. (2012) pointed out that, although a rise in F0 is widely recognised as a strategy to cope with vocal load (Jonsdottir et al., 2002; Rantala et al., 2002; Remacle, Morsomme, Berru , & Finck, 2012; Vilkmann, 2004), it is also considered a risk to vocal health due to the increased number of compressive and collisional stresses

applied to the vocal folds (I. R. Titze, 1994), and is an indicator of increased workload/vocal fatigue (Vilkman, 2004). Increased effort has been reported as an essential feature of vocal loading. Further, in the presence of any vocal performance difficulty the speaker will increase effort and this may lead to further vocal attrition and this can become a vicious circle (Vilkman, 2004). As there was no significant difference between VP and CON groups in the current study, the rise in F0 seems a common adaptation/compensation occurring in both groups toward vocal load or vocal fatigue, regardless of the vocal health status.

Based on acoustic analysis of the teachers' voices before starting the day and after the school day, voice changes (F0; signal to noise ratio, SNR) were also observed. F0 measured acoustically decreased at the end of the day for primary teachers only; whereas F0 measured with the APM increased for all teachers. Methodological differences may account for this apparent inconsistency. The APM measured spontaneous speech during regular school work, while the acoustic signal was measured before starting classes and after school (usually after a brief vocal rest) using a sustained vowel /ah/ produced at comfortable pitch and loudness. The difference in results between APM and the acoustic analysis in the current study is an intriguing result as most studies examining vocal load using these two approaches have shown that F0 did not change or increase over the day. Primary teachers started the day with high F0 compared to secondary teachers (Table 11); at the end of the day primary and secondary teachers did not differ. Thus, the finding of reduced F0 may be a result of some other factor causing a high F0 at the start of the day acoustic recording.

When environmental SPL values measured with the dosimeter were examined for the three parts of the teaching day, LAeq median dropped at the end of the day, while LAeq max and LCpeak max were higher in the middle and the end of the day. This finding of higher peak noise levels in the middle (including lunchtime) and at the end of the day, are consistent with noisier activities happening at these times. The drop in LAeq level at the end of the day is consistent with a change in activity; in future studies it would be helpful to have concurrent recordings to classroom activities to confirm this. APM measures showed that

teachers' voice levels did not vary significantly during the teaching day. Despite this, the comparison of APM and noise dosimetry levels is of interest as it indicates how the teacher uses their voice in response to noise challenges.

Correlations (F0, SPL, phonation time, environmental noise levels)

Based on the minute-by-minute analysis, voice SPL and F0 were positively correlated for both CON and VP groups of teachers. Similar patterns have been observed in other vocal dosimeter studies (Bottalico & Astolfi, 2012; Echternach, Nusseck, Dippold, Spahn, & Richter, 2014; Hunter & Titze, 2010). An increase in F0 with vocal intensity (positive correlation between F0 and voice SPL) has been shown in studies conducted in laboratory settings (Gramming et al., 1988; Remacle, Morsomme, et al., 2012) and teaching conditions (Echternach et al., 2014; Hunter, 2010). Echternach et al. (2014) analysed 101 healthy German teachers (males and females) during a vocal loading test in the lab and during a 45-min teaching lesson using a vocal dosimeter and found a positive correlation between F0 and voice SPL in both situations. To some degree F0 and voice SPL are physiologically interdependent (Debruyne & Buekers, 1997). It is thought that the mean F0 rise is induced by the increase in subglottic pressure that regulates loudness (Gramming et al., 1988). In contrast with the findings of the current study, Åhlander et al. (2014) found a positive correlation between F0 and SPL for healthy teachers only, across four activities at school (teaching lessons, break/planning, meeting, and lunch), while a negative correlation was observed for VP teachers. The authors suggested that the lack of increase in F0 with voice SPL is a possible indication of a voice problem (i.e. "reduced" vocal flexibility). The present study did not show this difference between VP and CON groups. Analyses differed between these studies however; in the current study, correlations were carried out on the average data per minute over the teaching time (340 points per day, averaged over each minute), which may have increased sensitivity due to the greater precision in the measurements.

Noise dosimetry measures (LAeq, LCpeak) were positively correlated with vocal load measures (F0, SPL, phonation time). Both CON and VP groups responded similarly to environmental noise changes, in accord with the Lombard effect (Bottalico & Astolfi, 2012; Junqua, 1996), with speakers automatically raising their voice when background noise increases. Current findings are in agreement with other dosimeter studies involving healthy teachers (Ehcternach et al., 2014) and teachers with and without VP (Pelegri n-Garc a, Lyberg- hlander, Rydell, Brunskog, & Lofqvist, 2010). Studies of non-teachers using acoustic measures in the lab (S odersten et al., 2005) and dosimeter measures in natural environments (not the classroom) (Yiu & Priscilla, 2015) also show this relationship between voice level and environmental noise. In the present study, voice levels increased by 0.72 dB per 1 dB increase in background noise level for CON teachers (Figure 15). These results corroborate the findings of Botallico and Astolfi (2012) and Sato and Bradley (2008) who both found a rise of 0.72 dB in speech per 1 dB increase in noise for primary school teachers. The average effect of noise on voice levels is remarkably consistent across dosimeter studies for primary and secondary teachers, however, Lindstrom et al. (2011) found individual variability in vocal behaviour under noise exposure among preschool teachers.

The use of a portable, mini noise dosimeter enables capture of the noise wherever the teacher is. The noise dosimeter is limited by the lower limit of 64 dBA SPL, and hence is not able to register very low noise levels (which could be a limitation). Dosimeter noise levels in the current study (*Md* 66-82 dB, *M* 68-81 dB LAeq) are consistent with reports in the literature for occupied classrooms. For instance, Dodd et al. reported classroom LAeq values of 62-77 dBC. Dockrell and Shield (2006) reported similar noise levels in occupied British classrooms of 72-76 dB LAeq during group activities. These noise levels indicate that teachers need to speak with a raised or loud voice to achieve an adequate signal-to-noise ratio to support their students' learning (Bradley, 1986).

Vocal load (phonation time, F0, SPL) is likely to increase with noise levels in the teaching environment. Voice levels (APM SPL) were not the only measures that were

positively correlated with noise levels; F0 and phonation time also increased with environmental noise in CON and VP groups. Bottalico and Astolfi (2012) found a positive correlation between F0 and noise level, with an increase of 1 Hz/dB (similar to the current study finding of 2 Hz/dB). On average VP teachers in the present study spoke more quietly than CON teachers however VP teachers reported increased vocal effort, difficulty with voice power and more throat discomfort, suggesting that CON teachers raised their voice in a healthier way.

With increasing environmental noise, teachers' vocal load tends to increase, and this is likely to increase the risk for voice problems through development of hyperfunctional voice use patterns. Voice and/or communication training could help teachers to use safer and more effective vocal projection strategies and more effective strategies for managing students' behaviour in the classroom in order to reduce environmental noise. In addition, use of amplification may be a valuable strategy for reducing vocal load, as long as teachers are trained in effective use of amplification devices. Improvements in classroom acoustics so that noise levels are reduced may also reduce risk. Psychosocial factors such as stress and mental fatigue associated with a poor teaching environment have not been not considered in the current study, but because these factors may also have a negative effect on vocal functioning, reducing classroom noise is likely to be a further strategy to enhance the vocal health of teachers (Kristiansen et al., 2014).

Future directions

Unique aspects of this study are the detailed minute-by-minute analyses of the teacher's voice and the environment, and the comparison of primary and secondary teachers. The tracking of changes over the day provides better tracking of vocal load as evidenced by changes in F0 and phonation time. With advances in technology teachers could receive rapid feedback on these voice changes, which could trigger a need to rest or change vocal behaviour. The data gathered on environmental noise levels suggests a need

for schools to be designed differently in physical terms; the APM and other dosimeters would be a powerful tool for evaluating the effects of such changes on vocal behaviour.

A limitation of the study that could be addressed in future research is the inclusion of just two days of voice monitoring. In addition, there was no recording of teaching activities, no data were gathered on teachers' perceptions of environmental noise, voice quality was not measured during the teaching day, and we were unable to recruit a large group of male teachers. It would be valuable to conduct further studies using noise dosimeter and detailed (e.g. minute-by-minute) measurements during different teaching activities, with documentation of classroom activities and behaviour management in the classroom. This could show how untrained and vocally trained teachers respond vocally to noisy or other challenging teaching situations (poor acoustic, noise and activities outside of classroom, stress, etc.). This could more clearly elucidate maladaptive vocal behaviors and the link between these behaviors and self-reported voice problems.

Vocal dose safety limits have not been established yet. Using vocal dose calculations, Titze and Hunter (2015) has recently proposed a damage risk criterion in excessive voice use based on the equal energy dissipation dose criterion that could be used to 'structure'/model trade-off relations between loudness, adduction, and duration of speech. This benchmark could become a risk-damage criterion for the development of a vocal injury or vocal fatigue in occupational voice users. This trade-off may be influenced by the dynamics of voice use over the day. Further studies with teachers taking into account voice symptoms, voice pathologies and activities over the day to support this proposal are needed.

Ongoing studies have been developing a new smartphone based device for monitoring voice use to identify and then alert individuals of hyperfunctional voice patterns (Ghassemi et al., 2014; Hillman et al., 2013; Mehta, Paul, et al., 2012; Mehta, Zañartu, et al., 2012). These studies involving more derived measures may add valuable information on the assessment of hyperfunctional voice disorders, as they allow observation of vocal patterns more precisely during daily activities and differences from baseline vocal behaviour can be monitored to reveal differences within individuals. Preliminary results for six participants with

vocal nodules and six healthy matched control teachers (Hillman et al., 2013) showed no difference in average phonation time, SPL, and distance dose between normal and hyperfunctional patterns. Differences were more evident when more extreme vocal behaviors were examined using derived features. This research group also investigated distributional features of F0 and SPL, such as skewness, kurtosis, and percentiles (5th and 95th) to enable identification of vocal patterns associated with hyperfunctional voice disorders and separation of 22 of 24 singers (N = 12 with vocal nodules; N = 12 healthy) (Ghassemi et al., 2014). The use of these features may help differentiate vocal patterns in teachers with self-reported voice problems, even in the absence of adducted hyperfunctional disorders. A very recent study from the same group involving 35 matched-pairs of individuals (including n = 28 pairs of singers and 2 pairs of teachers) with phonotraumatic lesions and controls showed no differences between the pairs for average F0, SPL, vocal dose, and voicing and silence periods. However, variability of F0 (SD, maximum, range) showed lower values for the vocal pathology group and hence were more sensitive than the traditional APM averages. Although these studies have been conducted with teachers and singers with vocal nodules to identify vocal behaviors associated with phonotrauma to improve diagnosis and treatment, it is also important that further investigations assess teachers with frequent self-reported voice problems/symptoms but no frank pathologies as these represent a large group amongst VP teachers.

Conclusions

Key findings of this study were:

- Phonation time (time dose) and voice SPL were the only parameters that differentiated the groups. VP group phonated longer, particularly primary teachers. CON teachers spoke louder than VP.
- F0 and phonation time were positively correlated with voice SPL for both groups.
- CON teachers' rooms were noisier (higher peak levels), suggesting classes are more dynamic.

- Overall, phonation time dropped and F0 increased over the teaching day for both groups.
- Voice parameters were correlated with noise dosimetry data. F0, voice SPL, and phonation time were positively correlated with environmental noise levels.

The results highlight several small but significant differences in voice parameters (phonation time, voice SPL) and environmental noise parameters between teachers with and without VPs across the teaching day, highlighting the need for more research to identify factors contributing to these differences. Detailed voice and environmental measurements, using a wider range of derived variables for the APM across the school day combined with behavioral observations in a prospective study could enhance our understanding of causes and treatments for voice problems in teachers.

Chapter 5: Overall Discussion

This concluding chapter summarizes the main findings across the three studies from this doctoral thesis, states potential limitations and implications, and suggests directions for future studies.

Prevalence of voice problems in teachers

The first study outlined in Chapter 2 used an epidemiological cross-sectional design to determine the prevalence and nature of voice problems in NZ teachers using a national self-report questionnaire. The study was carefully designed to estimate the true prevalence rates and provide a better perspective on voice problems in NZ by using three time-frames. The findings indicate that the prevalence rates for voice problems in NZ teachers are as high as those reported for other countries and thus voice problems are a major concern for NZ teachers. This is especially the case because the study revealed a lack of voice education and training during the participants' teaching training and professional lives.

Approximately one third (33%) of NZ teachers reported frequent voice problems during their teaching career, one quarter (24.7%) during the year-interval, and 13.2% on the day of the survey. The data are similar to findings of other studies with similar methodology, especially Russell et al. (1998) for Australian teachers and Charn and Mok (2012) for Singaporean teachers who used similar outcomes and timeframes, confirming the robustness of the study and the universality of voice problems in teachers.

Multivariate analyses were used to develop models for a range of factors that are thought to have an effect on the voice - including personal, environmental, and psychosocial factors, voice use, and other voice-related factors. This approach allows for the evaluation of the influence of multiple variables on voice. Primary school teachers, females, and those aged 51-60 years had approximately 50% greater odds of reporting voice problems than secondary school teachers, males, and other age groups, on the point prevalence outcome. Few epidemiological studies have found an increased risk for primary teachers for developing voice disorders compared to secondary teachers (M. Angelillo et al., 2009). Female gender and older age are well established as risk factors for voice problems (Roy et

al., 2004; Russell et al., 1998). The current findings highlight the importance of female teachers receiving voice training and advice before embarking on their teaching career. Hunter et al. (2011) discussed potential gender differences that may make women more vulnerable to the development of voice problems, such as laryngeal and endocrine differences, psychological status (e.g. stress, anxiety, and depression), and body hydration. Women have also been found to be more vulnerable to vocal overload in noisy environments (Södersten et al., 2005; Ternström, Bohman, & Södersten, 2006).

The literature has shown that not only teachers, but also teachers in training, have a high prevalence of self-reported voice problems (Ohlsson et al., 2012; Schneider & Bigenzahn, 2005; Thomas, De Jong, Cremers, & Kooijman, 2006). The high prevalence of voice problems in teachers highlights the need for effective and clinically feasible assessments for teachers with voice problems, and the development and evaluation of voice care and training programs.

There were no significant differences in prevalence of self-reported voice problems across school locations and ethnicity. Rural areas have more area schools. In NZ, teachers from area schools tend to have a higher number of students and may have increased working load due to the aggregation of children with different ages. This could potentially increase vocal loading in teachers at area schools, but this was not evident in the data. The effect of their vocal loads could potentially be offset by a more relaxed lifestyle that is often found in rural areas, and could account for the lack of difference in self-reported voice problems across school types. Direct measurement of vocal load in different locations and types of school would help to clarify this. Ethnicity effects have not been previously explored and hence ethnicity effects in other populations have not been established.

The studies reported in Table 1 have different quality study designs which may affect the validity of prevalence rates. Large sample size, random sampling, high response rate, and low risk of self-selection/information bias increase validity/accuracy of estimated prevalence rates. In study 1, the use of universal coverage (big and small cities, and rural

areas across the country; different school types), specific outcome definition, three time-frames, a representative sample of NZ teachers ensured that the study had high quality.

Severity

Study 1 revealed significant associations between severity and recovery time, severity and days away from work, and recovery time and absence days. As expected, teachers with more severe voice problems took longer to recover and their voice problems resulted in more days away from work. Among teachers reporting voice problems during the year, approximately half (47%) reported moderate/severe problems and a third (30%) took more than a week for their voice to recover. Approximately 28% stayed away from work 1-3 days due to a vocal problem and 9% stayed away for more than 3 days.

Women reported longer recovery times and more days away from work. These results are somewhat concerning. They suggest that teachers continue working despite the presence of a voice problem that limits their communication. It is very likely that job performance is affected (Smith, Kirchner, et al., 1998) and that their voice limitations negatively affect students' learning (Lyberg-Åhlander, Brännström, et al., 2015). It may be necessary, for example, for teachers to change their teaching style due to their voice limitations. The finding that 10% of teachers with voice problems missed work for at least 3 days in a year because of a voice problem is a special concern for the educational system (Pemberton et al., 2010) and students (Lyberg-Åhlander, Brännström, et al., 2015). Teachers would be more likely to take time off for their voice problems if they received paid time off for voice recovery time and if treatment was publically funded. In Poland, where certain laryngeal pathologies are considered occupationally-related diseases, voice disorders are the most common occupational disease (Sliwinska-Kowalska et al., 2006). Teachers from Study 3 were offered further advice on voice care and use and were given the opportunity to be referred for voice treatment, however most responded that they did not have time to attend treatment due to their busy schedules. This highlights the need for better

awareness-raising in the teaching community regarding the importance of maintaining a healthy voice.

Symptoms

Symptoms that were commonly reported in Study 1 are widely reported in the literature (Behlau et al., 2012; Smith et al., 1997). The most common and severe symptoms were throat discomfort, voice quality alteration, vocal fatigue, vocal effort, and singing difficulties. The symptoms that best differentiated the groups with and without voice problems could be used to screen for voice problems in teachers, especially as several of these symptoms are characteristic of muscle tension voice problems (Roy, 2008). Voice quality alteration (e.g. hoarseness) had the highest odds, followed by voice breaks, difficulty projecting the voice, throat discomfort, and increased vocal effort. These symptoms are related to muscle tension problems, which are typical of teachers (Fritzell, 1996). Vocal fatigue is a very frequently reported symptom in the literature for teachers (Åhlander et al., 2011; Munier & Kinsella, 2008; Smith, Kirchner, et al., 1998; Yiu, 2002) and was the third most common symptom in the current research. Both groups of teachers, with and without voice problems, reported similar amounts of vocal fatigue. Throat discomfort, which can be related to vocal fatigue (Ingo R Titze, 1984; Welham & Maclagan, 2003), did differ between the groups in Study 1. In Study 3 teachers with voice problems reported greater voice symptoms before and after the teaching day, especially throat discomfort and vocal effort. As discussed in Chapter 2, the inclusion of symptoms that were commonly reported in the teachers with voice problems and that differed between teachers with and without voice problems (e.g. throat discomfort, voice quality alteration, voice breaks, voice projection difficulties, vocal effort) is recommended for vocal screening or occupational health assessment protocols for teachers. Furthermore, according to other studies, it seems that some of these symptoms (vocal effort, throat discomfort and vocal fatigue) contribute disproportionately to reduced quality of life, voice-related absenteeism and activity limitations and restrictions (Behlau et al., 2012; Roy, Merrill, Thibeault, Gray, et al., 2004). In addition,

providing amplification for teachers with voice problems may reduce immediately those symptoms related to trying to speak loudly for long periods over classroom noise and the effects on teacher's life quality and work.

Help-seeking

Teachers should seek help when they experience voice limitations but Study 1 showed that typically NZ teachers do not do this. A concerning figure from Study 1 was that only 22% of teachers who reported voice problems consulted a health practitioner. Further, a cross-tab analysis of the number of chronic voice problems (>4 weeks to recover) and visits to a specialist, revealed that only around a quarter of teachers with chronic voice problems visited a specialist (otolaryngologist). To our knowledge, no previous studies have cross-tabbed their data to document this important finding.

Possible explanations for the teachers not seeking help for their voice problems were discussed in detail in Chapter 2. A related area that was not addressed in Study 2 but which should be considered in future studies relates to teachers' coping style. This is likely to influence how teachers cope with their voice problems, whether they use more 'problem-focused' strategies such as seeking treatment for their voice problem or whether they use an 'avoidance' coping style (Epstein & Hirani, 2011). A recent study found that teachers with voice problems who sought voice therapy tended to use 'problem-focused' strategies (Zambon et al., 2014), indicating that the teachers were looking for a solution for their voice problem.

Teachers were not asked for reasons for not seeking health assistance. Further research is required to find out why they don't seek help so that education and prevention strategies can be put in place to change their behaviour and the behaviour of the school management teams in this regard. Anecdotally, comments from participants in Study 3 suggest that busy life styles and time pressures may contribute to their lack of help-seeking.

It has been recommended that coping style is addressed in voice training programs for teachers as well as in intervention programs for those with voice disorders (Meulenbroek, Thomas, Kooijman, & de Jong, 2010; Van Opstal, 2010a, 2010b). Epstein and Hirani (2011) suggested that dysfunctional or maladaptive coping should be addressed in counselling and patient education. A surprising finding from Study 2 was that better voice quality was associated with an avoidance coping style. It is possible that teachers using this coping strategy were less engaged with activities that would have a negative impact on voice quality and were better at avoiding work-related stress. A qualitative research methodology that explores teachers' behaviors and perceptions in more detail might shed light on this finding.

Voice training and education

Study 1 showed that higher hours of voice training/education were associated with a lower frequency of voice problems in teachers. Voice training/education was treated as a categorical variable since this was not a key focus of Study 1. In Study 2 voice training/education was investigated in more detail and was treated as a continuous variable to increase statistical power. The results of Study 2 confirmed those of Study 1; increased hours of voice training were associated with fewer symptoms and better voice-related quality of life. Although voice care programs and direct voice training in teachers have been shown to be effective (Bovo, Galceran, Petruccelli, & Hatzopoulos, 2007; Ilomaki et al., 2008; Pemberton et al., 2010), especially when regular meetings are included throughout the year, further prospective longitudinal studies, are needed to establish the effectiveness and feasibility of such programs for NZ teachers.

Factors associated with voice problems in teachers

Epidemiological cross-sectional studies are valuable for exploring factors associated with a disease or condition. Although there have been a reasonable number of previous studies exploring factors associated with voice problems in teachers (Alvear, Martínez, et al.,

2010; S. H. Chen et al., 2010; Kooijman et al., 2006; Roy, Merrill, Thibeault, Parsa, et al., 2004; Russell, 1999; Russell et al., 1998; Sampaio et al., 2012; Ubillos et al., 2015; Van Houtte et al., 2012). Study 2 used a methodological approach that increased the robustness and generalizability of the findings, and controlled for age and gender when exploring different potential risk factors for voice problems. The methodology included: a) use of standardised questionnaires to assess psychosocial and other factors such as reflux, b) use of a holistic investigation approach including factors and outcomes in line with the ICF framework, and c) use of multivariate analysis to examine the association of a multitude of factors with each outcome measure.

Multivariate analyses conducted in Study 2 revealed significant associations between personal, vocal loading, environmental, and psychosocial factors and voice problems and voice-related quality of life. Harmful voice use patterns and reflux (Koufman, 1991; Koufman & Blalock, 1982; Morrison & Rammage, 1993) were associated with poor voice outcomes, confirming previous reports of a high prevalence of reflux in voice patients (Koufman, 1991) and teachers/professional voice users (Fernández & López, 2003; Van Houtte et al., 2012; Van Houtte et al., 2010) and the relationship between vocal misuse and voice problems (e.g. hyperfunctional voice problems), respectively. Other factors associated with poor voice outcomes were increased noise in the room, stress, lower hours of voice education/training and voice rest periods, upper respiratory tract infections such as the common cold, and exposure to chemicals during teaching. Among the psychosocial factors, extraversion, self-efficacy, job satisfaction, openness to experience, agreeableness, and avoidance were associated with better voice outcomes. These results are generally consistent with previous clinical, laboratory and field studies (although not for avoidance). Study 2 focused on potential antecedent factors for voice problems in teachers, however, it is not clear whether the psychosocial factors shown to be associated with voice problems are causal, precipitating, co-incidental, or the consequence of voice problems. This is a question that should be investigated using prospective longitudinal study designs, combined with field

investigations so that associations with vocal load and environment can be investigated. Structural equation modelling could be useful in future research, for example, to explore the mediating effects of coping on the relationships between severity of voice problems and psychological well-being. This approach has been adopted in other health areas such as hearing loss (Meyer & Kashubeck-West, 2013).

Teaching level

Teaching level was investigated in all three studies in this thesis. In Study 1 primary teachers were more likely to report voice problems (point prevalence outcome), while in the second study, when other variables were taken into account, teaching level did not appear as significant in any model. Study 2 used multivariate analyses and teaching level may not have been significant due to co-variance with other factors. In Study 3, when teaching level was considered for the overall day analysis, primary teachers with voice problems had higher phonation times than healthy primary and secondary teachers. There have been very few long-term vocal monitoring field studies comparing teaching levels, however one study (Remacle et al., 2014) showed that pre-school teachers had higher vocal dose than elementary teachers and hence differences in voice risk between primary and secondary teachers are still not well delineated. Better information on the effects of teaching level would help to inform voice education programs.

Preventing voice problems in teachers

It is fortunate that many of the psychosocial factors identified in Study 2 are modifiable by the teachers themselves (e.g., coping style) and/or by school management (e.g., work-related stress, job satisfaction). These results highlight relevant psychosocial factors that should be addressed in preventive voice programs and in clinical management of voice problems in the teaching population. The findings regarding relevant psychosocial factors support the use of a multifactorial approach when discussing potential risks for voice problems in teachers in preventative programs. These aspects could be added to existing

voice ergonomic protocols such as the Voice Ergonomic Assessment in Work Environment - Handbook and Checklist (Sala et al., 2009). The Voice Ergonomic Assessment in Work Environment - Handbook and Checklist considers stress, but no other psychosocial factors, and hence could be improved on the basis of the current research findings. This appears to be the only published tool for systematically assessing risk of voice disorders in the work environment.

Vocal load

Work-related factors such as vocal load, background noise, room acoustics, and air quality are well documented risk factors for voice problems in teachers (Rantala et al., 2012; Vilkmán, 2004). However, very few studies have examined such factors in field conditions (at school) and voice use during teaching work (Åhlander et al., 2014). Study 3 investigated differences in vocal load, the acoustic environment, and self-assessment of voice between teachers with and without voice problems. This study showed that teachers with voice problems spoke for longer periods of time and more quietly, and that they had more frequent and more severe symptoms (particularly after the working day) than teachers without voice problems. Few other group differences were found in vocal load parameters. Only the data from female teachers were analysed statistically due to the small number of male teachers that were recruited. Teachers with voice problems reported worse voice symptoms, especially vocal effort and throat discomfort (before and after teaching day) in comparison with controls. Longer phonation times may reflect the need of these teachers to repeat themselves to be understood by students due to their voice limitation or perhaps these teachers tend to overuse or misuse their voice. The finding that teachers with voice problems speak more quietly is consistent with the teachers experiencing muscle tension problems (Van Houtte, Van Lierde, et al., 2011).

All teachers from both VP and control groups showed an increase in F0 and a decrease in phonation time over the teaching day, consistent with a number of previous studies showing a gradual rise in F0 over the day. It has been hypothesised that this is

related to the “lack of muscle relaxation when the larynx remains primed all day for speech” (Titze & Hunter, 2015, p. 23). Study 3 also showed that F0 and phonation time were positively correlated with voice SPL for both groups. This is in contrast with Åhlander et al.’s (2014) finding of different correlations for each group, but this discrepancy could reflect methodological differences between the studies. For example, Åhlander et al. compared results across several different activities during the school day rather than examining results over the entire teaching day.

Study 3 demonstrated the important role of voice dosimetry in voice research. The number of voice dosimeter studies with teachers and other occupational voice users has been gradually increasing over the years (Åhlander et al., 2014; Hunter & Titze, 2010; Morrow & Connor, 2011; Portela et al., 2013; Remacle et al., 2014; I. R. Titze et al., 2007). These studies have shown a range of findings that are important for understanding voice problems in teachers, including the following: a) teachers phonate more than other occupations, b) teachers phonate twice as much during the work day as they do during their non-occupational time, c) kindergarten teachers have higher vocal loading than elementary teachers, d) music teachers have higher vocal loading than classroom teachers, e) amplification tends to reduce vocal loading in teachers with and without voice problems, f) teachers with voice problems have higher phonation times. Study 3 adds to these findings by highlighting that teachers with voice problems have higher phonation time (particularly primary teachers) and speak more quietly. Very few teachers in this research were using voice amplification and hence it was not possible to determine effects of this on voice problems or vocal load. This is an area that needs further research, especially as Study 3 highlighted the high noise levels and probable poor signal to noise ratios in classrooms of all teachers.

Noise in the teaching environment

Study 3 showed links between vocal load, voice problems, and environmental influences in field conditions. The noise dosimetry data showed that the control group

teachers' rooms were noisier (higher peak levels) than those of the VP teachers. It is not clear why this difference occurred but it does suggest that classes are more dynamic for teachers without voice problems, perhaps because the teachers without voice problems were more able to vary both their teaching and vocal styles. When noise levels (median LAeq) were examined over the teaching day they were found to have dropped at the end of the day. Voice parameters were correlated with noise dosimetry data for teachers with and without voice problems; F0, voice SPL, and phonation time were positively correlated with environmental noise levels. These correlations support the inclusion of noise dosimetry in future studies to better understand voice use in field conditions for teachers.

Unique aspects of Study 3 were the detailed minute-by-minute analyses of the teacher's voice and the environment, and the comparison of primary and secondary teachers. The findings of Study 3 would be enhanced by more detailed information on the teachers' activities over the course of the day. Documentation of classroom activities and behaviour management in the classroom could show how teachers respond vocally to noisy or other challenging teaching situations (e.g., poor acoustics, noise and activities outside of classroom, stress). This could more clearly elucidate maladaptive vocal behaviors and the link between these behaviors and voice problems. This information, in turn, would be helpful for the development of voice education programs designed to reduce voice problems in teachers by increasing awareness and knowledge, improving voice function, and changing vocal behaviour.

Information regarding potential voice ergonomic risks is not only important to teachers and clinicians but, as noted by Rantala et al. (2012), this information needs to reach educational authorities and people responsible for classroom design. Voice ergonomic assessment in schools should be included in occupational health care surveys. Rantala et al. suggested that only comprehensive actions such as this will decrease the prevalence of voice problems, provide sustained recovery and improve voice function and spoken communication in the workplace. Modern learning environments being developed currently in NZ schools have a great deal of glass and other reflective surfaces and have been built to

improve lighting and to be semi-open and open. Unfortunately this may increase ergonomic voice risk through increased background noise.

Study design and limitations

All three studies conducted for this thesis were cross-sectional and observational. Hence it is not possible to know the temporal sequence of potential antecedent factors and voice problems. Despite this limitation, the three studies contribute to the literature by providing new information on voice problems in NZ teachers, the varied factors that are potential antecedents of a range of voice outcomes for teachers, and the link between vocal load and the teaching environment in field conditions for NZ teachers.

One of the more important limitations of this research is that in studies 1 and 2 self-report measures were used to determine the presence of reflux, other medical conditions, and voice use behaviors as well as several other dependent and independent variables. The reliability and validity of many of these self-report measures had been demonstrated in previous research, but this was not the case for all measures. Further research to establish the psychometric properties of the non-standardized self-report questionnaire items is required.

The decision was made to conduct two separate studies to estimate the prevalence and nature of voice problems in teachers (Study 1), and to investigate risk factors (Study 2) because a short questionnaire was needed in Study 1 to ensure a good response rate and sample size, important considerations when estimating prevalence. The sample for the second study was not random and this could be a possible limitation (participants were recruited from the pool of respondents to the Study 1 questionnaire). It is possible that teachers who answered the first questionnaire had changed their vocal behaviour or harmful voice habits after responding to the first survey. Based on personal voluntary comments made in the survey, some teachers increased their knowledge about their voice and potential harmful habits just by answering the survey. Self-selection bias was reduced, however, by ensuring that the wording of the study invitation was as neutral as possible and

highlighting the importance of voice for teaching rather than focussing on voice problems. In addition, a good response rate was achieved and the study sample was representative of the NZ teaching population.

The use of online surveys has been shown to be very effective (Baruch & Holtom, 2008), especially in a small country like NZ, where most teachers have access to computers and internet in their work. This allowed the survey to reach all parts of the country and to be supported by teachers' unions that have access to teachers' email details (via union representatives). This was a low-cost and convenient approach. A disadvantage of this approach was that it was not possible to control for any interruptions when teachers completed the survey or to prevent teachers from discussing the survey with colleagues. Further, a small number of questionnaires had to be discarded when teachers did not complete all key questions.

Study 3 involved two days of vocal and noise monitoring at school during typical teaching work (using the ambulatory phonation monitor, APM, and a noise dosimeter). It would be valuable in future research to extend this to monitor outside of school hours to assess how teachers with voice problems use their voice during non-working hours. Dosimetry outside of school hours has not been reported in the scientific literature as yet, but it is feasible that teachers' vocal load outside of work contributes to the development of vocal problems. In the current study, the SPL measures from the APM were similar to other reports in the literature that used the same device [e.g. Nacci et al. (2013) and Remacle et al. (2013)] supporting the stability of the SPL results.

Information gathered from more extensive vocal load analysis may also contribute to the establishment of guidelines for safe occupational voice use for teachers. Vocal dose safety limits have not yet been established (Titze et al., 2003). Revisiting the vocal dose calculations, Titze and Hunter (2015) recently proposed a damage criteria dose "benchmark equal-dose criterion from speaking at different frequencies, loudnesses and duration" (p. 20). They stated that this benchmark could become a risk-damage criterion for the development of a vocal injury or vocal fatigue in teachers, one that considers the trade-off between F0,

voice levels, and phonation time (e.g., higher F0 means reduced voice level to maintain the same dose). This trade-off may be influenced by the dynamics of voice use over the day and hence monitoring over the entire day is needed. Further studies with teachers that include assessment of vocal load, voice symptoms, voice disorders, and activities over the day are needed to determine whether there is support for Titze and Hunter's (2013) criterion and to know how one would implement this to ensure that teachers' vocal doses in the workplace are safe. Duration of phonation could be managed, for example, by including more pauses and dialogue into daily speech (Titze & Hunter, 2015).

Future directions

As noted above, safe vocal doses are yet to be established. Further research is needed to test Titze and Hunter's (2015) equal-energy-dissipation criterion for quantifying the trade-off between F0, loudness, vocal fold adduction, and duration of speech and to verify the best trade-off between amplitude (loudness), vocal fold collisions, and speaking duration. The combination of loudness and voice quality training (less adduction) could have a significant impact on the teaching profession by reducing the vibration exposure risk.

The influence of voice rest periods was highlighted in studies 2 and 3. Increased voice rest breaks were associated with better voice quality and voice functioning on the V-RQOL. In study 3, the fact that teachers with voice problems had significantly greater phonation time than teachers without voice problems highlights the need to educate teachers about effective voice rest management. Relatively little is known about optimal voice education programs. All three studies in this thesis have provided valuable insights into the effects of high vocal load and risk factors for voice problems that could be incorporated into a standardised voice education programme. Further research using a randomised control design is needed in order to establish the efficacy of such training for preventing or reducing voice problems in teachers. Preventative educational programs delivered in a group format in the work environment have been shown to improve the quality of life of workers (Pizolato 2013). The effectiveness of this format could be explored in future voice

education studies. There are other important questions about prevention programs to investigate too such as the relative effectiveness of targeting voice production technique versus voice care behaviors, health versus environmental factors, psychosocial factors versus vocal load factors, coping strategies versus self-efficacy, and so on. It is not known whether such education programs would need to target all the associated factors identified in this research or whether targeting certain factors is more effective than targeting others, or whether such programs would need to be individualised.

Ongoing studies have been developing new mobile technologies for monitoring voice use to alert individuals to their use of hyperfunctional voice patterns (Mehta et al., 2012, Ghassemi, 2014; Hillman, 2014). These studies may add valuable information on the assessment of hyperfunctional voice disorders, as they allow observation of vocal patterns in detail during daily activities and differences over the school day from baseline vocal behaviour can be monitored. These researchers have investigated distributional features of F0 and SPL, such as skewness, kurtosis, and percentiles (5th and 95th) to enable identification of vocal patterns associated with hyperfunctional voice disorders (Ghassemi, 2014). The use of these features may help differentiate vocal patterns in teachers with self-reported voice problems from those of vocally healthy teachers. F0 variability measures (SD, maximum, range) differed between teachers with vocal pathology and controls and hence were more sensitive than traditional APM averages. Although these studies have been conducted with teachers and singers with vocal nodules to identify vocal behaviors associated with phonotrauma, these measures may also be useful for assessing teachers with self-reported voice problems. The APM was the only voice dosimeter commercialized when this thesis was proposed. It is clear that the use of vocal dosimetry for individual vocal load assessment and vocal feedback is valuable, however, anecdotally it seems that the devices should be smaller and lower-cost to facilitate widespread clinical and research use. A low-cost smartphone-based dosimeter would allow the increased use of these devices and could improve access to assessment and treatment of vocal problems.

Study 3 showed relatively few differences between teachers with voice problems and control teachers. Future studies that include more detailed analyses over a working/non-working period and other F0 measures such as SD (standard deviation), coefficient of variation, and range and other derived measures highlighted by Ghassemi et al. (2014) may better differentiate teachers with voice problems from controls. When using the APM, it was necessary to work with the raw data and derive values in Excel after considerable, highly time-consuming data processing. It is recommended that MATLAB algorithms be derived to facilitate future analyses of complex APM data. More automated and sophisticated data processing would encourage more widespread use of this technology for voice research.

Environmental noise levels measured in the classroom in study 3 were very high and exceeded recommended levels for effective teaching (ANSI/ASA, 2010). This highlights the need to improve and monitor classroom noise and reverberation levels and to ensure that schools adhere to published guidelines on safe limits for classroom noise levels. The high noise levels found in study 3 indicate that voice amplification systems may be needed in many schools to reduce teacher's vocal load (especially loud speaking for long periods over the noise) and protect teachers' voices, and to ensure effective learning for students, particularly for teachers with voice problems.

Closing Remarks

This thesis has demonstrated that voice problems are an important health issue among NZ teachers, as has been reported worldwide. This research has provided the statistics needed for establishing the scope of voice problems in NZ and the need for voice intervention and preventative education. There is still limited awareness among teachers about vocal health, potential risks, and specialised health services for voice problems. Targeted education and treatment programs that consider individual vocal load and risk factors may be needed to optimise intervention outcomes for different teaching groups. Female teachers are at particular risk and make up the majority of the teaching work force and hence it is critical that voice education and treatment programs are maximally effective

for this group. A great deal of research and clinical effort is needed to prevent and better manage voice disorders in teachers. The present research has provided a scientific basis for such programs for NZ teachers (e.g. implementation of a national voice care/voice training program) and others who work in similar teaching environments and under similar vocal demands.

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APPENDICES

5. Please send a copy of this approval letter to the Manager - Funding Processes at Research Office if you have obtained any funding other than from UniServices. For UniServices contract, please send a copy of the approval letter to the Contract Manager at UniServices.

6. Please note that the Committee may from time to time conduct audits of approved projects to ensure that the research has been carried out according to the approval that was given.

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Distribution of Teachers according to Teaching Subject for Study 1 and 2

Study 1

Teaching subject	N	%
Secondary - main subject		
Chemistry	46	2.4
Languages / ESOL	76	4
PE / Sports / Outdoor Ed	58	3.1
Music	37	2
Drama / Dance	32	1.7
Visual Arts	55	2.9
Technology	72	3.8
Special Education	18	1
Economics / Accounting / Business Studies	45	2.4
Health & Home Economics	31	1.6
Computing / Digital Tech / Graphics / Design & Visual Communication	72	3.8
Physics	36	1.9
General Science	79	4.2
Agriculture / Horticulture	6	0.3
Other	108	5.7
Biology	49	2.6
Geography	44	2.3
History	41	2.2
Social Studies	48	2.6
Maths / Statistics	164	8.7
English	249	13.3
Te Reo Maori	28	1.5
Primary		
National Curriculum only	356	18.9
Specialist Subjects only	32	1.7
Both	80	4.3
Other	2	0.1
Total	1879	100

Study 2

Teaching Subject	N	%
Science	161	28.1
Music / Drama / Dance / PE / Sports / Outdoor Ed	43	7.5
Languages	123	21.5
Social Science / Health / Others	78	13.6
National Curriculum / Specialist Subject	167	29.2
Total	572	100

Voice Use in NZ Teachers - Survey 1

* 1. Have you been working as a school teacher over the last 12 months?

- Yes
- No

Voice Use in NZ Teachers - Survey 1

Information

Dear Teacher,

Thank you for clicking on the link to help us with our research. Your participation is invaluable in helping us to better understand how New Zealand teachers use their voice at work in order to create effective vocal care programmes.

It is really easy to fill out this questionnaire. It should take you less than 10 minutes. Once you have started you cannot exit and go back, so answer the survey when you have 10 minutes free to do it.

The questions ask about your voice use at work and demographic characteristics. Please read the questionnaire carefully and answer ALL the questions. Complete this questionnaire only ONE time. If you are unsure about how to answer a question, give the best response you can.

***Once a page in the survey is submitted, you cannot go back and change existing responses. If you want to edit past responses you should click 'exit' (on the top) and restart through the survey's link.*

All of your response data will be kept STRICTLY CONFIDENTIAL and only the researchers will have access to your individual responses.

This survey will close on 31st May 2011. Please fill out this survey as soon as you can.

Proceed to the next question if you can confirm the following:

"I have read and understood this information about the aims and content of the following questionnaire. I understand that, by submitting this questionnaire electronically I agree to take part in this research."

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 08/09/2010 FOR THREE (3) YEARS, REFERENCE 2010/459.

*Speech Science
The University of Auckland*

Voice Use in NZ Teachers - Survey 1

Personal Details

* 2. Which of the following organisations do you belong to?

- NZEI
- PPTA
- I do not belong to a Union
- Other

Other (please specify)

* 3. Are you...

- female
- male

Voice Use in NZ Teachers - Survey 1

* 4. Please record your date of birth below:

Date of birth DD MM YYYY
 / /

* 5. Which ethnic group do you belong to?

Please mark all that apply

- | | |
|---|---|
| <input type="checkbox"/> New Zealand European | <input type="checkbox"/> Middle Eastern |
| <input type="checkbox"/> Māori | <input type="checkbox"/> Latin American |
| <input type="checkbox"/> European | <input type="checkbox"/> African |
| <input type="checkbox"/> Pacific Islander | <input type="checkbox"/> Other |
| <input type="checkbox"/> Asian | |

If you have indicated 'Other', please specify

Voice Use in NZ Teachers - Survey 1

*** 6. What class level(s) do you teach?**

Please mark ALL that apply

- Year 0-1
- Year 2
- Year 3-6
- Year 7-8
- Year 9-13
- Other

If you have indicated 'Other', please specify

*** 7. In what type of school do you work?**

Please mark all that apply

- Primary school
- Intermediate school
- Secondary school
- Area school
- Other

If you have indicated 'Other', please specify

Voice Use in NZ Teachers - Survey 1

*** 8. Are you...**

- Primary and/or Intermediate teacher (i.e. teach Year 1-6 or Year 1-8)
- Secondary teacher (defined here as: teaching a specialist subject at Year 7 or above)
- Other

If you have indicated 'Other', please specify

Voice Use in NZ Teachers - Survey 1

Primary and Intermediate Teachers

*** 9. Nowadays you teach...**

Please indicate the most appropriate option

- All subjects in the national curriculum ONLY
- Specialist subjects ONLY
- All subjects in the national curriculum + specialist subjects
- Other

If you have marked 'Other', please specify

Voice Use in NZ Teachers - Survey 1

Primary and Intermediate Teachers - Specialist Subject(s)

10. Which specialist subject(s) do you teach?

Please indicate all that apply

- | | |
|------------------------------------|---|
| <input type="checkbox"/> Music | <input type="checkbox"/> Technical Studies |
| <input type="checkbox"/> Art | <input type="checkbox"/> IT |
| <input type="checkbox"/> Dance | <input type="checkbox"/> Reading Recovery |
| <input type="checkbox"/> Drama | <input type="checkbox"/> Physical Education |
| <input type="checkbox"/> Languages | <input type="checkbox"/> Other |

If you have indicated 'Other', please specify

Voice Use in NZ Teachers - Survey 1

Secondary Teachers - Teaching Subject(s)

* 11. What subject(s) do you teach?

Please indicate all that apply

- | | |
|---|---|
| <input type="checkbox"/> Chemistry | <input type="checkbox"/> Music |
| <input type="checkbox"/> Physics | <input type="checkbox"/> Drama/Dance |
| <input type="checkbox"/> Biology | <input type="checkbox"/> Visual Arts |
| <input type="checkbox"/> Geography | <input type="checkbox"/> Technology |
| <input type="checkbox"/> History | <input type="checkbox"/> Special Education |
| <input type="checkbox"/> Social Studies | <input type="checkbox"/> Economics/Accounting/Business Studies |
| <input type="checkbox"/> Maths/Statistics | <input type="checkbox"/> Health and Home Economics |
| <input type="checkbox"/> English | <input type="checkbox"/> Computing/Digital Technology/Graphics/Design & Visual
Communication |
| <input type="checkbox"/> Te Reo Maori | <input type="checkbox"/> General Science |
| <input type="checkbox"/> Languages/ESOL | <input type="checkbox"/> Agriculture/Horticulture |
| <input type="checkbox"/> PE/Sports/Outdoor Ed | <input type="checkbox"/> Other |

If you have indicated 'Other', please specify

*** 12. For secondary teachers only. What is the MAIN subject you teach?**

Please indicate the most appropriate option

- | | |
|--|--|
| <input type="radio"/> Chemistry | <input type="radio"/> Music |
| <input type="radio"/> Physics | <input type="radio"/> Drama/Dance |
| <input type="radio"/> Biology | <input type="radio"/> Visual Arts |
| <input type="radio"/> Geography | <input type="radio"/> Technology |
| <input type="radio"/> History | <input type="radio"/> Special Education |
| <input type="radio"/> Social Studies | <input type="radio"/> Economics/Accounting/Business Studies |
| <input type="radio"/> Maths/Statistics | <input type="radio"/> Health and Home Economics |
| <input type="radio"/> English | <input type="radio"/> Computing/Digital Technology/Graphics/Design & Visual
Communication |
| <input type="radio"/> Te Reo Maori | <input type="radio"/> General Science |
| <input type="radio"/> Languages/ESOL | <input type="radio"/> Agriculture/Horticulture |
| <input type="radio"/> PE/Sports/Outdoor Ed | <input type="radio"/> Other |

If you have indicated 'Other', please specify

Voice Use in NZ Teachers - Survey 1

* 13. In which New Zealand region do you work?

Big city - Please specify the name of city:

Small town - Please specify the name of town:

Rural or semi-rural area - Please specify the name of area:

Voice Use in NZ Teachers - Survey 1

*** 14. Thinking of your career as a teacher... How many YEARS have you actually been teaching?**

Please write to the nearest whole number. Do not insert any words (e.g. years) or a decimal number.

*** 15. On average, how many HOURS PER WEEK do you work as a teacher (including outside the school day)?**

Please write to the nearest whole number

*** 16. On average, what is the length of a teaching work day in HOURS for you (including outside the school day)?**

Please indicate the nearest whole number

*** 17. On average, how many STUDENTS are there in your classroom / teaching environment?**

Please write to the nearest whole number

Voice Use in NZ Teachers - Survey 1

Teaching Environment

*** 18. Does the classroom that you teach in most of the time have acoustic treatment (e.g special ceiling tiles, amplification system)?**

Note you can indicate more than one option

- No
- I do not know
- Not applicable (because I do not teach in classroom)
- Yes - special ceiling tiles
- Yes - amplification system (microphone and loudspeakers)
- Yes - Other

If you have indicated 'Yes - Other', please specify

*** 19. On average, how many HOURS PER WEEK do you teach in these environments?**

Please indicate the nearest whole number.

- | | |
|------------------------------|----------------------|
| In a classroom | <input type="text"/> |
| In an open plan classroom | <input type="text"/> |
| In a library | <input type="text"/> |
| In a laboratory | <input type="text"/> |
| In the sports field | <input type="text"/> |
| In a drama theatre | <input type="text"/> |
| In an art room | <input type="text"/> |
| In a music room /theatre | <input type="text"/> |
| In a hall | <input type="text"/> |
| Other (please specify hours) | <input type="text"/> |

Voice Use in NZ Teachers - Survey 1

Vocal Training and/or Voice Care Program

* 20. Have you ever had any vocal training and/or participated in a voice care programme?

Note you can indicate more than one option

- Yes - Vocal training
- Yes - Voice care programme
- No

Voice Use in NZ Teachers - Survey 1

* 21. Please estimate how many hours in total you have attended a vocal training and/or voice care programme:

Please write the nearest whole number. Insert "0" for the not applicable option.

Vocal training

Voice care programme

* 22. When did you attend a vocal training and/or voice care programme?

- Before I trained as a teacher
- During teaching training
- Since I qualified as a teacher

Voice Use in NZ Teachers - Survey 1

Voice Use at Work

The following questions are about your voice. Firstly, it is important to define what a vocal problem is for the purpose of this research.

A vocal problem can occur at any time. When there is a vocal problem, your voice changes or does not work as you expect, preventing you from using your voice in a satisfactory way. It may sound hoarse, raspy, creaky, breathy, weak, too high, too low, too soft, or may disappear entirely.

Voice Use in NZ Teachers - Survey 1

The next two questions relate to your WHOLE TEACHING CAREER.

*** 23. During your TEACHING CAREER, how often have you had a problem with your voice which prevented you from doing all you wanted to with it?**

Please indicate the option which is the most appropriate for you

- I have NEVER had a vocal problem during my teaching career
- Rarely
- Once every 2-3 years
- Once a year
- Twice a year
- Several times per year (between 3 and 11 times per year)
- Monthly or more frequently (e.g. fortnightly, weekly)

Voice Use in NZ Teachers - Survey 1

* 24. When you had a problem with your voice during your TEACHING CAREER, how long, on average did it take for your voice to return to normal?

Please indicate the option which is the most appropriate for you

- Less than one day
- More than one day but less than one week
- 1 – 2 weeks
- 3 – 4 weeks
- More than 4 weeks
- My voice has NOT returned to normal

Voice Use in NZ Teachers - Survey 1

The next two questions relate to your voice TODAY.

*** 25. Do you have a problem with your voice TODAY which is preventing you from doing all you want with it?**

Yes

No

Voice Use in NZ Teachers - Survey 1

* 26. What is the degree of severity of your vocal problem TODAY?

Please indicate the option which is the most appropriate for you

- Very mild
- Mild
- Moderate
- Severe
- Very severe

Voice Use in NZ Teachers - Survey 1

The next six questions relate to the 2010 TEACHING YEAR.

*** 27. During the 2010 TEACHING YEAR, how often did you have a problem with your voice which prevented you from doing all you wanted to with it?**

Please indicate only one option which is the most appropriate for you

- I did NOT have a vocal problem in the current teaching year
- Once in 9 months
- Once every couple of months
- Monthly
- Fortnightly
- Weekly
- Daily

Voice Use in NZ Teachers - Survey 1

*** 28. On average, what was the degree of severity of your vocal problem in the 2010 TEACHING YEAR?**

Please indicate only one option which is the most appropriate for you

- Very mild
- Mild
- Moderate
- Severe
- Very severe

*** 29. When you had a problem with your voice during the 2010 TEACHING YEAR, how long, on average did it take for your voice to return to normal?**

Please indicate only one option

- Less than one day
- More than one day but less than one week
- 1 – 2 weeks
- 3 – 4 weeks
- More than 4 weeks
- My voice has NOT returned to normal

Voice Use in NZ Teachers - Survey 1

*** 30. During the 2010 TEACHING YEAR, how many days were you away from work because of a vocal problem?**

Please indicate the approximate number of days:

- 0 (zero)
- 1 - 3 days
- 4 - 7 days
- 8 - 14 days
- 15 - 30 days
- 31 - 60 days
- More than 60 days

*** 31. Did you consult any medical/health professional because of a vocal problem during the 2010 TEACHING YEAR?**

- Yes
- No

Voice Use in NZ Teachers - Survey 1

* 32. How frequently did you seek medical/health advice from the following professionals because of a **VOCAL PROBLEM** in the 2010 TEACHING YEAR?

Please specify how many VISITS...

Write the nearest whole number. Insert number '0' for not applicable options.

GP (General Practice) or Family Doctor

ENT (Ear, Nose & Throat specialist)

SLT (Speech-Language Therapist)

Physiotherapist

Other

Voice Use in NZ Teachers - Survey 1

* 33. During your lifetime, have you been diagnosed with any vocal problem by an Ear, Nose & Throat (ENT) specialist / Otorhinolaryngologist (ORL)?

Yes

No

Voice Use in NZ Teachers - Survey 1

* 34. Please specify any diagnoses and date(s) these were made. If you have more than one diagnosis, please write all that apply followed by dates.

Voice Use in NZ Teachers - Survey 1

Vocal Difficulties

* 35. Please indicate how often you have been experiencing any of the difficulties listed below during the 2010 TEACHING YEAR.

Please indicate on average:

	Never	Seldom	Sometimes	Often	Every time I use my voice
Alteration of voice quality (e.g. hoarseness, roughness, huskiness, strained voice, weak voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal effort (e.g. effort or force needed to speak)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal fatigue (e.g. tired voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Complete loss of voice (voice disappears completely)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alteration of voice pitch (e.g. different pitch than usual such as pitch too high, too low, smaller pitch range, uncontrolled pitch)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alterations of voice loudness/volume (e.g. too soft, loud, uncontrolled loudness, difficulty making the voice as loud or as soft as needed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voice breaks or cracks during speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weak voice/difficulty projecting my voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Throat discomfort (e.g. throat pain, dryness, burning, tightness, cough/clearing throat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Breathing difficulties (e.g. shortness of breath or running out of breath while speaking, noisy breathing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Singing difficulties (e.g. difficulty to reach high notes, voice breaks during singing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify below)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Description of other symptom(s) and how often:

*** 36. Based on your responses to question above, please indicate the degree of severity you have been experiencing for any of the difficulties listed below during the 2010 TEACHING YEAR.**

Please indicate on average:

	Very Mild	Mild	Moderate	Severe	Very severe	N/A
Alteration of voice quality (e.g. hoarseness, roughness, huskiness, strained voice, weak voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal effort (e.g. effort or force needed to speak)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal fatigue (e.g. tired voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Complete loss of voice (voice disappears completely)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alteration of voice pitch (e.g. different pitch than usual - pitch too high, too low, smaller pitch range, uncontrolled pitch)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alterations of voice loudness/volume (e.g. too soft, loud, uncontrolled loudness, difficulty making the voice as loud or as soft as needed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voice breaks or cracks during speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weak voice/difficulty projecting my voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Throat discomfort (e.g. throat pain, dryness, burning, tightness, cough/clearing throat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Breathing difficulties (e.g. shortness of breath or running out of breath while speaking, noisy breathing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Singing difficulties (e.g. difficulty to reach high notes, voice breaks during singing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify below)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Description of other symptom(s) and degree of severity:

Voice Use in NZ Teachers - Survey 1

37. Thank you so much for assisting us by taking time out of your busy day to answer our questions! We would be delighted if you could help us further by participating in the second phase of this research.

This involves a further online questionnaire asking a few more details about how you use your voice at work and possible factors that may influence your voice.

If you can help us, please write your EMAIL address below. All of your personal data and your responses will be kept strictly confidential.

We greatly appreciate your participation and collaboration.

Email

Alternative Email

38. Please feel free to add any comment about your voice and/or about this questionnaire.

Voice Use in NZ Teachers - Survey 1

Thank you very much for completing this survey! We greatly appreciate your participation.

All of your personal data and your responses will be kept strictly CONFIDENTIAL.

A summary of our findings will be made available through the teachers' unions.

Please do not forget to click 'SEND' in the next page in order to send your responses.

Voice Use in NZ Teachers - Survey 1

Survey completed

Thank you for your participation.

Voice Use in NZ Teachers - Survey 2

Survey information

Dear Teacher,

Thank you for taking the time to complete this questionnaire. We greatly appreciate your participation!

In this second questionnaire you will answer questions with more details about your voice and related factors. Please read each question carefully and if you are unsure, give the best response you can.

This survey will take between 20 and 35 minutes to complete so please answer it when you have approximately 35 minutes free to complete it in one sitting. The closing date for this questionnaire is 9th December 2011.

As we cannot identify who you are when you respond to this survey, we need to repeat some questions from the first questionnaire. If you are uncomfortable answering any question, please leave the survey by clicking on Exit at the top of the page.

All of your responses will be kept STRICTLY CONFIDENTIAL.

Teachers who complete the survey can go into a draw to receive a \$50 petrol or shopping voucher. Please provide your email address at the end of the survey, if you would like to do this. Ten vouchers will be distributed.

Thank you for your support so far. It is really important to have a large number of responses in order to improve our understanding of NZ teachers' voices. This survey will facilitate better voice care for teachers.

Proceed to the next question if you can confirm the following: "I have read and understood this information about the aims and content of the following questionnaire. I understand that, by submitting this questionnaire electronically I agree to take part in this research."

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 08/10/2011 FOR THREE (3) YEARS, REFERENCE 2010/459.

*Speech Science
The University of Auckland*

Voice Use in NZ Teachers - Survey 2

1. How many years have you been in teaching altogether?

Please write the nearest whole number.

Voice Use in NZ Teachers - Survey 2

2. How many hours per week are you employed as a teacher?

Please write the nearest whole number

3. How many actual teaching hours do you have with students per day (for a typical teaching day)?

Please write the nearest whole number

4. On average, how many students are there in your classroom or main teaching space (outside, workshop, gymnasium, etc)?

Please record the average number of students per classroom and/or teaching space.

Voice Use in NZ Teachers - Survey 2

5. In what type of school do you work?

Mark all that apply

- | | |
|---|--|
| <input type="checkbox"/> Full Primary | <input type="checkbox"/> Secondary Years 7-15 |
| <input type="checkbox"/> Contributing Primary | <input type="checkbox"/> Secondary Years 9-15 |
| <input type="checkbox"/> Intermediate | <input type="checkbox"/> Special |
| <input type="checkbox"/> Composite | <input type="checkbox"/> Correspondence School |
| <input type="checkbox"/> Restricted Composite | |
| <input type="checkbox"/> Other (please specify) | |

Voice Use in NZ Teachers - Survey 2

6. Do you work in:

- Private school
- State school
- State Integrated school
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

7. Do you currently work as:

- Primary teacher / Intermediate teacher (i.e. teach Year 1-6 or Year 1-8)
- Secondary teacher (defined here as: teaching a specialist subject at Year 7 or above)
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

8. What do you currently teach?

- National curriculum ONLY
- Specialist subjects ONLY
- All subjects in the national curriculum + specialist subjects

If you teach specialist subject(s), please specify:

Voice Use in NZ Teachers - Survey 2

9. What is the main subject you teach?

- | | | |
|--|--|---|
| <input type="radio"/> Chemistry | <input type="radio"/> English | <input type="radio"/> Visual Arts |
| <input type="radio"/> Physics | <input type="radio"/> Te Reo Maori | <input type="radio"/> Technology |
| <input type="radio"/> Biology | <input type="radio"/> Languages/ESOL | <input type="radio"/> Economics/Accounting/Business
Studies |
| <input type="radio"/> Geography | <input type="radio"/> PE/Sports/Outdoor Ed | <input type="radio"/> Agriculture/Horticulture |
| <input type="radio"/> History | <input type="radio"/> Music | <input type="radio"/> General Science |
| <input type="radio"/> Social Studies | <input type="radio"/> Drama/Dance | <input type="radio"/> Computing/Digital
Technology/Graphics/Design & Visual
Communication |
| <input type="radio"/> Maths/statistics | <input type="radio"/> Religious Studies/Philosophy | |
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

10. What do you teach?

- Singing only
- Musical instrument only
- Singing + musical instrument

If you teach a musical instrument, please specify:

Voice Use in NZ Teachers - Survey 2

11. Over the past 12 months, have you engaged in any activities (other than teaching) that require you to use your voice extensively?

Yes

No

Voice Use in NZ Teachers - Survey 2

12. Which other activity?

Mark all that apply

- Singing
- Salesperson
- Acting
- Public speaking
- Other (please specify)

13. On average, how many hours per week have you engaged in these other activities?

Please write the nearest whole number

14. Have you had a problem with your voice during these activities?

- Yes
- No

Voice Use in NZ Teachers - Survey 2

Teaching environment

15. On average, how many hours per week do you teach in these environments?

Please write the nearest whole number. Leave blank if you don't teach in a specific environment

In a classroom

In an open plan classroom

In a gymnasium

On the sports field

In a library

In a music room/theatre

In a drama theatre

In a art room

In a laboratory

Other (please specify where and number of hours)

Voice Use in NZ Teachers - Survey 2

16. How often do you use the following styles when teaching?

	Not at all or very little	A moderate amount	A great deal
Mat work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Small group work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blackboard/Didactic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Free activity/choosing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching outside	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify the style and how often you use it)

Voice Use in NZ Teachers - Survey 2

17. In what situations do you find it is necessary to increase the loudness/volume of your voice to be clearly heard?

Please mark all that apply

- Mat work
- Small group work
- Blackboard/Didactic
- Free activity/choosing
- Teaching outside
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

18. How often do you use the following positions during teaching?

	Not at all or very little	A moderate amount	A great deal	N/A
In front of the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walking around	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talking to small groups in different parts of the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talking to the whole class in a smaller physical space than the entire room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify the position and how often you use it)

Voice Use in NZ Teachers - Survey 2

19. How noisy is your classroom or your usual teaching space?

- Not at all noisy
 Slightly noisy
 Moderately noisy
 Very noisy
 Extremely noisy

20. To what extent do the following aspects of your classroom or teaching space make it difficult for you to use your voice?

	(1) Does not make it difficult at all	2	3	(4) Extremely difficult	N/A
Noise in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Background noise from outside room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Echo in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sound absorption (sounds and voices seem muffled)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

Voice Use in NZ Teachers - Survey 2

21. Thinking about the physical characteristics of your main teaching space, how do you rate your main teaching space as a speaking environment?

- Poor Acceptable Good

22. Does your classroom have any acoustic treatment?

- N/A (I do not teach in a classroom)
 I don't know
 No
 Yes (please specify)

Voice Use in NZ Teachers - Survey 2

23. How would you rate the air quality (e.g. temperature, humidity, dustiness, fumes, etc) of your classroom or teaching space?

Poor
 Adequate
 Good

24. To what extent do the following aspects of your classroom or teaching space make it difficult for you to use your voice?

	(1) Does not make it difficult at all	2	3	(4) Extremely difficult	N/A
Dry air quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Humid air quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mould or mustiness in room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dust in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cold or draughty room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

Voice Use in NZ Teachers - Survey 2

25. Do you use a voice amplifier during your classes?

Yes

No

Voice Use in NZ Teachers - Survey 2

26. What type of voice amplifier?

Mark all that apply

- Sound field / loudspeaker
- Personal FM for some children
- Portable one (speaker on the belt)
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

27. Why have you started using voice amplifier?

Mark all that apply

- Because of a voice problem
- To prevent voice injury
- Because the school asked me to use it
- To make it easier for the students to hear me
- Other reason (please specify)

28. How much does the voice amplifier help your voice use?

(1) Not helpful
at all

2

3

(4) Extremely
helpful

Rate from 1 to 4, where 1
is 'not helpful at all' and 4
is 'extremely' helpful

Voice Use in NZ Teachers - Survey 2

29. Are any chemical substances (e.g. laboratory chemicals, mercury, paints, solvents, oil, photo processing chemicals) used in your classes?

Yes

No

Voice Use in NZ Teachers - Survey 2

30. What types of chemical substances are usually used in your classes?

31. On average, how often are this/these chemical substance(s) used?

- Once a week
- Twice a week
- More than twice a week
- Other (please specify)

32. Have you ever had throat or voice difficulties during or after using this/these substance(s) in your class?

- Yes
- No

Voice Use in NZ Teachers - Survey 2

33. How often do you do the following in a typical work day?

	not at all or very		
	little	a moderate amount	a great deal
Talk loudly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk using an unnatural pitch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk with vocal force or strain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk using an unnatural voice quality (e.g. raspy voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talk quickly with few pauses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sing loudly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sing using an unnatural pitch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sing with vocal force or strain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sing using an unnatural voice quality (e.g. raspy)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shout / yell/ scream / cheer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Laugh loudly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear you throat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cough	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

Voice use at work

Please answer the following questions based on a TYPICAL TEACHING DAY...

34. On a typical teaching day, how many hours on average do use your voice?

Please write the nearest whole number

35. On a typical teaching day, how many breaks do you have in which you are able to rest your voice?

Please write the nearest whole number

36. On a typical teaching day, how many minutes can you rest your voice:

Morning tea break

Lunchtime

Other (please specify minutes)

Voice Use in NZ Teachers - Survey 2

Voice use at work and at home / Voice rest

37. On a typical teaching day, on average, how much do you speak during your break times at school?

- Not at all or very little A moderate amount A great deal

38. Do you think you have enough time to rest your voice during your work day at school?

- Never or rarely Sometimes Often or always

39. How much have you used audiovisual and/or other equipment for resting your voice?

- Not at all or very little A moderate amount A great deal N/A

40. How much do you speak at home after your day at work?

- Not at all or very little A moderate amount A great deal

Voice Use in NZ Teachers - Survey 2

Vocal training & Voice care programme

41. Have you ever participated in any vocal training or voice care programmes?

- Yes - Vocal training only
- Yes - Vocal care program only
- Yes - Vocal training and voice care program
- No

Voice Use in NZ Teachers - Survey 2

42. For how many hours in total did you attend the vocal training and/or voice care program?

Please write the nearest whole number

43. How often have you used the following strategies from the vocal training or voice care program when teaching?

	Not at all or very little	A moderate amount	A great deal
I drink water when I use my voice during teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do warm-up exercises before my class	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I use a voice amplifier	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I monitor the volume/loudness of my voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I monitor the pitch of my voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I monitor the rate of my speech (e.g. I keep short pauses while speaking)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I articulate well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get close to my students when I speak	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I rest my voice during breaks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify the strategy and the frequency you use it)

Voice Use in NZ Teachers - Survey 2

About your voice

The following questions are about your voice. Firstly, it is important to define what a vocal problem is for the purpose of this research.

A vocal problem can occur at any time. When there is a vocal problem, your voice changes or does not work as you expect, preventing you from doing all you wanted to with it. It may sound hoarse, raspy, creaky, breathy, weak, too high, too low, too soft, or may disappear entirely.

Voice Use in NZ Teachers - Survey 2

44. How would you rate the quality of your voice in the last 12 months?

(1) Poor 2 3 (4) Excellent

Please rate from 1 to 4 where 1 is
'poor' and 4 is 'excellent':

Voice Use in NZ Teachers - Survey 2

The following question is about your voice during your TEACHING CAREER.

45. During your TEACHING CAREER, how often have you had a problem with your voice which prevented you from doing all you wanted to with it?

Please indicate the option which is the most appropriate for you

- I have NEVER had a vocal problem during my teaching career (including today)
- Rarely
- Once every 2-3 years
- Once a year
- Twice a year
- Several times per year (between 3 and 11 times per year)
- Monthly or more frequently (e.g. fortnightly, weekly)

Voice Use in NZ Teachers - Survey 2

46. Do you have a problem with your voice TODAY which is preventing you from doing all you want with it?

Yes

No

Voice Use in NZ Teachers - Survey 2

47. How would you rate the severity of your voice problem today?

Slight

Mild

Moderate

Severe

Voice Use in NZ Teachers - Survey 2

The next questions are about your voice during the past 12 months.

Voice Use in NZ Teachers - Survey 2

48. During the past 12 months, how often have you had a problem with your voice which prevented you from doing all you wanted to with it?

Please indicate the option which is the most appropriate for you

- I have NOT had a vocal problem in the past 12 months
- Once in 9 months
- Once every couple of months
- Monthly
- Fortnightly
- Weekly
- Daily

Voice Use in NZ Teachers - Survey 2

49. On average, how would you rate the severity of your voice problem in the last 12 months?

- Slight Mild Moderate Severe

50. How would you describe your voice problem?

- Constant/Continuous
 It comes and goes
 Other (please specify)

Voice Use in NZ Teachers - Survey 2

51. During a typical day, when is your voice problem usually worst?

Mark all that apply

- In the morning
- In the middle of the day
- Later in the day, after I use my voice at work
- My voice problem doesn't change over the day
- Other (please specify)

52. During a typical week, when is your voice problem usually worst?

Mark all that apply

- At the beginning of the week
- In the middle of the week
- At the end of the teaching week
- My voice problem doesn't change over the week
- Other (please specify)

53. During the school term, when is your voice problem usually worst?

Mark all that apply

- In the first two weeks of the school term
- In the middle of the school term
- At the end of the school term
- My voice problem doesn't change over the school term
- Other (please specify)

Voice Use in NZ Teachers - Survey 2

54. When you had a problem with your voice in the last 12 months, how long, on average did it take for your voice to return to normal?

- Less than 1 day
- More than 1 day but less than 1 week
- 1-2 weeks
- 3-4 weeks
- More than 4 weeks
- My voice has NOT returned to normal

55. Approximately how many days have you been away from work in the last 12 months because of a voice problem?

Please write the nearest whole number

Voice Use in NZ Teachers - Survey 2

56. Did you consult any medical/health professional because of a vocal problem in the last 12 months?

Yes

No

Voice Use in NZ Teachers - Survey 2

57. From which type of medical or health professional did you seek help because of a problem with your voice in the past 12 months?

Please mark all that apply

GP (General Practitioner) or Family doctor

ENT (Ear, Nose and Throat specialist)

SLT (Speech-Language Therapist)

Physiotherapist

Other (please specify)

Voice Use in NZ Teachers - Survey 2

58. Please indicate how often you have experienced any of the difficulties listed below during the past 12 months:

	Never or rarely	Sometimes	Often or always
Alteration of voice quality (e.g. hoarseness, roughness, huskiness, strained voice, weak voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal effort (i.e. increased effort or force needed to speak)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal fatigue (i.e. tired voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Complete loss of voice (only whispering is possible)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alteration of voice pitch (e.g. different pitch than usual such as pitch too high, too low, smaller pitch range, uncontrolled pitch)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voice breaks or cracks during speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty projecting my voice/weak voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Throat discomfort (e.g. throat pain, lump in the throat, dryness, burning, tightness, cough/clearing throat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Breathing difficulties (i.e. shortness of breath or running out of breath while speaking, noisy breathing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Singing difficulties (i.e. difficulty reaching high notes, voice breaks during singing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

59. Based on your responses above, please indicate the severity of each voice symptom you have experienced during the past 12 months:

	Slight	Mild	Moderate	Severe	N/A
Alteration of voice quality (e.g. hoarseness, roughness, huskiness, strained voice, weak voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal effort (i.e. increased effort or force needed to speak)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocal fatigue (i.e. tired voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Complete loss of voice (only whispering is possible)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alteration of voice pitch (e.g. different pitch than usual such as pitch too high, too low, smaller pitch range, uncontrolled pitch)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voice breaks or cracks during speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty projecting my voice/weak voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Throat discomfort (e.g. throat pain, lump in the throat, dryness, burning, tightness, cough/clearing throat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Breathing difficulties (i.e. shortness of breath or running out of breath while speaking, noisy breathing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Singing difficulties (i.e. difficulty reaching high notes, voice breaks during singing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

Voice Use in NZ Teachers - Survey 2

60. Do you believe that your voice is affected by your work as a teacher?

- Yes
 No

61. Have you ever had to change your role in the school because of your voice?

- Yes
 No

62. Have you actively considered leaving the teaching profession because of your voice?

- Yes
 No

63. If needed, would you have the financial resources to allow you to take leave to rest your voice?

- Yes
 No

Voice Use in NZ Teachers - Survey 2

You will notice that this question has some similar items to those in the past questions. Despite this, we do need you to answer both questions because they tell us about slightly different aspects of your voice. You will also notice that the question below asks you to think about just the past month.

64. Within the LAST MONTH, how did the following problems affect you?

Mark the appropriate response in a rating scale from 0 to 5

	No problem (0)	1	2	3	4	Severe problem (5)
Hoarseness or a problem with your voice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clearing your throat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Excess throat mucus or postnasal drip	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty swallowing food, liquids, or pills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coughing after you ate or after lying down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Breathing difficulties or choking episodes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Troublesome or annoying cough	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sensations of something sticking in your throat or a lump in your throat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Heartburn, chest pain, indigestion, or stomach acid coming up	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

65. Answer the items below based upon what your voice has been like over the past two weeks. There are no "right" or "wrong" answers. Please rate each item below on how "bad" it is (that is, the amount of each problem that you have).

Because of my voice,

	None, not a problem (1)	A small amount (2)	A moderate (medium) amount (3)	A lot (4)	Problem is as "bad as it can be" (5)
I have trouble speaking loudly or being heard in noisy situations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I run out of air and need to take frequent breaths when talking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I sometimes do not know what will come out when I begin speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am sometimes anxious or frustrated (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I sometimes get depressed (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have trouble using the telephone (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have trouble doing my job or practising my profession (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I avoid going out socially (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have to repeat myself to be understood	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have become less outgoing (because of my voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

Job satisfaction

66. Overall, how satisfied are you with your job?

(1) Very
dissatisfied 2 3 (4) Very
satisfied

Please rate from 1 to 4, where 1 is
'very dissatisfied' and 4 is 'very
satisfied':

Voice Use in NZ Teachers - Survey 2

Personality

67. Here are a number of personality traits that may or may not apply to you. Please indicate the extent to which you agree or disagree with each statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as:

	Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
Extroverted, enthusiastic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Critical, quarrelsome	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dependable, self-disciplined	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anxious, easily upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Open to new experiences, complex	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reserved, quiet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sympathetic, warm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disorganised, careless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calm, emotionally stable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conventional, uncreative	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

68. Read each statement and mark which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of time	Applied to me very much, or most of the time
I found it hard to wind down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was aware of dryness of my mouth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I couldn't seem to experience any positive feeling at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found it difficult to work up the initiative to do things	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I tended to over-react to situations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experienced trembling (e.g. in the hands)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt that I was using a lot of nervous energy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was worried about situations in which I might panic and make a fool of myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt that I had nothing to look forward to	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found myself getting agitated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found it difficult to relax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt down-hearted and blue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was intolerant of anything that kept me from getting on with what I was doing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt I was close to panic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was unable to become enthusiastic about anything	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt I wasn't worth much as a person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt that I was rather touchy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of time	Applied to me very much, or most of the time
I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt scared without any good reason	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt that life was meaningless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

69. The following are ways people react to various difficult, stressful, or upsetting situations. Please mark a number from 1 to 5 for each item. Indicate how much you engage in these types of activities when you encounter a difficult, stressful or upsetting situation.

	Not at all (1)	2	3	4	Very much (5)
Take some time off and get away from the situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Focus on the problem and see how I can solve it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blame myself for having gotten into this situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Treat myself to a favourite food or snack	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feel anxious about not being able to cope	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Think about how I solved similar problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visit a friend	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Determine a course of action and follow it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy myself something	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blame myself for being too emotional about the situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work to understand the situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Become very upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Take corrective action immediately	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blame myself for not knowing what to do	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spend time with a special person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Think about the event and learn from my mistakes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wish that I could change what had happened or how I felt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Go out for a snack or meal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Analyze my problem before reacting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Focus on my general inadequacies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Phone a friend	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

70. Read carefully the following statements and indicate in how applicable they are to you. You have five different possible answers for each statement.

	(1) strongly disagree	2	3	4	(5) strongly agree
I will be able to achieve most of the goals that I have set for myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When facing difficult tasks, I am certain that I will accomplish them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In general, I think that I can obtain outcomes that are important to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe I can succeed at most any endeavour to which I set my mind	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will be able to successfully overcome many challenges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident that I can perform effectively on many different tasks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Compared to other people, I can do most tasks very well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Even when things are tough, I can perform quite well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

About your job

71. Please indicate the extent to which you agree or disagree with each statement:

	(1) strongly disagree	(2)	(3)	(4)	(5) strongly agree
I work with intensity on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I exert my full effort to my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I try my hardest to perform well on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I exert a lot of energy on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am enthusiastic in my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am interested in my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel positive about my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am excited about my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At work, my mind is focused on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At work, I focus a great deal of attention on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At work, I am absorbed by my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At work, I concentrate on my job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

About your health

72. The following list is about common medical conditions. Please indicate those you have previously been diagnosed with, and whether you are experiencing symptoms currently.

Note you may indicate more than one option ('been diagnosed' and 'current symptoms')

	Never been diagnosed	Been diagnosed	Current symptoms
Hypothyroidism (underactive thyroid gland)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hyperthyroidism (overactive thyroid gland)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High blood pressure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hearing problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Throat or larynx cancer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Asthma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pneumonia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Autoimmune disease (e.g. lupus, rheumatoid arthritis, etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Allergies (please specify below)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (e.g. neurological disease, cancer, etc). Please specify below.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other (please specify)

Voice Use in NZ Teachers - Survey 2

About your health

73. In the last 12 months, how many times have you had the following conditions?

	Never	1-2 episodes	3-4 episodes	5-7 episodes	More than 7 episodes
Sinus infections (rhinitis and/or sinusitis)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Laryngitis/throat infections	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Colds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Voice Use in NZ Teachers - Survey 2

Medication

74. What medications have you taken in the last 12 months?

In addition, indicate the frequency you have taken the medications (e.g. daily, 2 weeks a year, 3 times a year, etc)

Voice Use in NZ Teachers - Survey 2

75. How often did you have a drink containing alcohol in the last 12 months?

- Never
- Less than once a week
- 1-3 times a week
- 4-6 times a week
- 7 or more times a week

Voice Use in NZ Teachers - Survey 2

76. On average, how many standard drinks containing alcohol do you have on a typical day when you are drinking?

- 1 or 2
- 3 or 4
- 5 or 6
- More than 6

Voice Use in NZ Teachers - Survey 2

77. How much water do you drink per day? (1 cup/glass=250ml)

- 2 or less than 2 cups/glasses
- 3-4 cups/glasses
- 5-6 cups/glasses
- 7-8 cups/glasses
- More than 8 cups/glasses

Voice Use in NZ Teachers - Survey 2

78. Are you a current smoker?

- Yes
- No. I smoked in the past for a year or longer
- No. I have never smoked (or smoked for less than a year)

Voice Use in NZ Teachers - Survey 2

79. How long have you been smoking for?

Please write the nearest whole
number

80. On average, how many cigarettes (or others) do you smoke per day?

Please write the nearest whole
number

Voice Use in NZ Teachers - Survey 2

81. Please indicate for how many years you smoked:

Please write the nearest whole
number

82. On average, how many cigarettes did you smoke per day?

Please write the nearest whole number

Voice Use in NZ Teachers - Survey 2

83. What sex are you?

- Male
- Female

Voice Use in NZ Teachers - Survey 2

84. Are you pregnant?

Yes

No

85. Are you having menopausal symptoms?

Yes

No

Voice Use in NZ Teachers - Survey 2

86. What is your ethnicity?

(Note that ethnicity refers to your cultural identity, not your citizenship or birthplace)

Mark all that apply to you

- | | |
|---|---|
| <input type="checkbox"/> NZ European/Pakeha | <input type="checkbox"/> Asian |
| <input type="checkbox"/> Māori | <input type="checkbox"/> Middle Eastern |
| <input type="checkbox"/> European | <input type="checkbox"/> Latin American |
| <input type="checkbox"/> Pacific Island people | <input type="checkbox"/> African |
| <input type="checkbox"/> Other (please specify) | |

87. What is the postcode of your school's location?

If you don't know the postcode, please write the name of the area/town/city. You can write both if you want.

Postcode:

Area/Town/City:

Voice Use in NZ Teachers - Survey 2

88. How many dependent children do you have at home?

(Please write the number of children for each educational level. If you don't have children, please leave blank and go to the next question)

Pre-school

Primary school

Secondary school

Tertiary education

Other (please specify)

Voice Use in NZ Teachers - Survey 2

Age

We would prefer to have your date of birth for our research. If you are not comfortable with this, please indicate your age category/group.

89. Which category below includes your age?

- | | |
|--------------------------------|-----------------------------------|
| <input type="radio"/> under 24 | <input type="radio"/> 50 - 54 |
| <input type="radio"/> 25 - 29 | <input type="radio"/> 55 - 59 |
| <input type="radio"/> 30 - 34 | <input type="radio"/> 60 - 64 |
| <input type="radio"/> 35 - 39 | <input type="radio"/> 65 - 69 |
| <input type="radio"/> 40 - 44 | <input type="radio"/> 70 and over |
| <input type="radio"/> 45 - 49 | |

90. Please record your date of birth:

Please note the correct format - day, month, year

	DD		MM		YYYY
	<input type="text"/>	/	<input type="text"/>	/	<input type="text"/>

Voice Use in NZ Teachers - Survey 2

Thank you so much for assisting us by taking time out of your busy day to answer our questions! Your responses are really important for this research!

91. If you want to go into a draw to receive a \$50 petrol or shopping voucher, please provide your email address below in order for us to contact you:

Name:

Email Address:

Voice Use in NZ Teachers - Survey 2

92. If you work in a school in Auckland, we would be delighted if you could help us further by participating in the last phase of this research which involves analysis of your voice.

If you would like more information about this last phase, please provide your contact details below. All of your personal data and your responses will be kept strictly confidential.

Name

Email address

Alternative email address

Phone number

93. Feel free to make any comment about your voice and/or this survey:

Voice Use in NZ Teachers - Survey 2

Thank You!

THANK YOU you very much for answering this survey! We greatly appreciate your participation!

The study findings will be reported in the union's journal or website.

If you think you have a problem with your voice, please consult a GP and/ or a specialist (Ear, Nose & Throat or Speech Language Therapist) for a better evaluation and treatment. The researchers will be happy to answer questions about this process if you would like to email us.