Vocal characteristics of school-aged children with and without attention deficit hyperactivity disorder

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A dissertation submitted in fulfillment of the requirements for the degree MA Speech-Language Pathology in the Department of Speech-Language Pathology and Audiology at the University of Pretoria, Faculty of Humanities

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“Somewhere, something incredible is waiting to be known.”

-Carl Sagan-

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"So don't throw away your confidence—it brings a great reward. You need to endure so that you can receive the promises after you do God's will. **(**Hebrews 10:35-36)

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List of Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
CNS	Central nervous system
DSI	Dysphonia severity index
ENT	Ear-, nose and throat specialist (otorhinolaryngologist)
GRBASI	Grade (hoarseness), roughness, breathiness, asteny, strain and instability
HFVD	Hyperfunctional voice disorder
LoLT	Language of learning and teaching
LMIC	Low and middle income countries
LSES	Low socioeconomic status
MDVP	Multidimensional Voice Program
NPO	Non-profit organization
PPS	Pretoria Preparatory School
pVHI	Paediatric Voice Handicap Index (questionnaire)
SES	Socioeconomic status
VADPRS	Vanderbilt ADHD Diagnostic Parent Rating Scale
VF	Vocal folds
VFN	Vocal fold nodule(s)
VRP	Voice Range Profile

Formatting

APA referencing style was used in this dissertation

Abstract

The aim of this study was to describe the laryngeal anatomy, perceptual, acoustic and aerodynamic vocal characteristics of school-aged children with and without ADHD. The predisposition that children with ADHD have for laryngeal injuries are recurrent in nature and are more often than not overlooked as laryngitis. Previous studies have reported varied results on the prevalence rates of paediatric VFN within the school-aged ADHD population. A static, two-group comparison was used in the study to investigate the clinical, perceptual, acoustic and aerodynamic vocal characteristics of children between 7 and 9 years old with and without ADHD. The study replicated the protocol as executed by Barona-Lleo and Fernandez (2016) with additions. The Multidimensional Voice Program (MDVP) and the Voice Range Profile (VRP) as additions to the assessment of vocal parameters were used with which comparable dysphonia severity index (DSI) scores were calculated. Once-off clinical, perceptual, acoustic and aerodynamic voice assessments were conducted on 20 age-gender matched participants. The difference in assessment results between the vocal characteristics of children without a history of ADHD (control group) and those of children with ADHD (ADHD group) was then investigated and described. Forty five percent (n=9) of the total sample population had laryngeal pathology. Comparable parent reported etiological voice symptoms and vocal habits were seen across both groups. Both groups performed similarly across both perceptual and aerodynamic voice assessments. Acoustically, the control group achieved significantly higher producible pitches than the ADHD group (p=0.028) and were found to have more dysphonic DSI scores than their ADHD group peers (p=0.034). Prepubertal, school-aged children with or without ADHD may have similar vocal characteristics than previously thought. This variation in school-aged children warrants further research into larger sample sizes with this population with a special focus on the effect that CNS stimulants may have on the voice.

Key Words: Paediatric voice disorders–Attention deficit hyperactivity disorder–vocal fold nodules– Multidimensional Voice Program – Voice Range Profile - Dysphonia severity index.

1. Introduction

Chapter aim: The chapter provides background on the paucity in research regarding the vocal characteristics of school-aged children with and without ADHD. A justification for the inclusion of speech therapy voice assessment and further management of all school-aged children is explored. An argument is formulated for the inclusion of all school-aged children with voice problems to receive early voice assessments and therapeutic services to prevent the occurrence of childhood voice disorders. Advocacy for increased awareness and support among parents and/or caregivers regarding good vocal hygiene and habits is made.

Attention Deficit Hyperactivity Disorder (ADHD) is the single most common heterogeneous paediatric psychiatric disorder (Centers for Disease Control and Prevention, 2016). It is characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development in various contexts (Spencer, Biederman, Wilens, & Faraone, 2002; American Psychiatric Association, 2013). Internationally the prevalence of ADHD in primary school children is estimated between five to eight percent (Polanczyk, de Lima, Horta, Biederman, & Rhode, 2007; Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014; Thomas, Sanders, Doust, Beller, & Glasziou, 2015; Wilcut, 2012). In a systematic review and meta-analysis, similar prevalence rates were reported in North America, Europe, Australasia, South America, Asia, Africa and the Middle East (Polanczyk et al., 2014). In South Africa a recent clinical audit at the Red Cross War Memorial Hospital, reported paediatric ADHD prevalence rates of 8.5% (Vrba, Vogel, & de Vries, 2016).

A review of the epidemiology of ADHD among children from the Democratic Republic of Congo, Nigeria, Ethiopia and South Africa, reported that a number of predisposing factors play a role in the high prevalence of the disorder (Bakare, 2012). Factors include level of parental education, parental mental health status, familial conflict and structure, being male, perinatal consumption of/exposure to toxins (especially tobacco and/or alcohol), difficulties during childbirth, brain injury as well as HIV/AIDS (Bakare, 2012; Vrba et al., 2016). These factors leave people from low and middle income households vulnerable to ADHD and its commonly associated comorbid psychiatric illnesses (Bakare, 2012; Vrba et al., 2016). Many of these risk factors

exist within South African communities where the majority of people have a low socioeconomic status (LSES) (Vrba et al., 2016).

Approximately 60% of children with ADHD experience other significant comorbid impairments (Ercan et al., 2013; Gillberg, 1983; Jensen, Martin, & Cantwell, 1997; Zorlu et al., 2015). These impairments include, amongst others, substantial speech-language and social communication difficulties. Children with ADHD acquire and process language in different ways than their age-matched peers. They struggle to learn effectively in classroom settings which may lead to poor academic achievement and even failing grades (Hamdan et al., 2009). In addition they show difficulty in understanding intention to communicate and prosody changes (changes in vocal pitch and intensity) (Garcia-Real, Diaz-Roman, Garcia-Martinez, & Vieiro-Iglesias, 2013). Such impairments may limit social interaction in subversive ways (Bishop & Baird, 2001; Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004). A child may also overexert their voice, which is also known as *talkativeness*, a hyperkinetic behaviour common in children with ADHD (Hamdan et al., 2009).

“Talking too much” coupled with reduced self-monitoring of emotional reactions, communicative intent and nonverbal cues, may lead to high-pitched, rapid rates of talking at uncomfortable intensity levels which inflict phonotrauma onto laryngeal structures (Garcia-Real et al., 2013; Roy, 2003; Van Houtte, Van Lierde, & Claeys, 2011). Consequently, excessive laryngeal and extra-laryngeal muscle tension can result in such instances where phonotraumatic behaviours are further exacerbated which may lead to vocal fold nodules (VFN).

Few studies have reported on the prevalence of voice problems in the general paediatric population (Kiliç, Okur, Yildirim, & Güzelsoy, 2004; Shah, Woodnorth, Glynn, & Nuss, 2005; Angelillo et al., 2008). Studies report incidence rates as low as 1% and as high as almost 23.4% (Kiliç et al., 2004). The wide range in reported incidence may be due to many factors, such as differences in methodology (i.e. survey methods, criteria for voice characteristics), the time period authors investigated, limited sample sizes as well as people not seeking professional help for dysphonia-related symptoms due to a lack of awareness. Physiologically, school-aged children are more prone to dysphonias due to the reduced amount of elastin in the vocal folds (VF) that serve to stabilize the vibratory force for phonation (Kallvik,

Lindström, Holmqvist, Lindman, & Simberg, 2015). Additionally, previous research has demonstrated that when there is an organic predisposition (such as in children with a reduced amount of elastin in their VF to dysphonia, only then are personality traits, social behaviours, familial structure and environmental factors that are common in children significiant in causing possible vocal overloading (Kallvik et al., 2015). When these factors coincide, two main categories of voice problems can occur – organic lesion dysphonias or non-organic functional dysphonias.

The most commonly diagnosed voice problem in school-aged children is VFN (Kiliç, et al., 2004) Reported VFN prevalence rates reach over 21% in male children and over 11% in female children (Kiliç et al., 2004). Authors included the laryngoscopic examinations and acoustic analyses of 617 Turkish school-aged children. The results of their assessments indicate that the reported prevalence of VFN in school-aged children was found to be 16.9%. In a retrospective review of 646 patients, 40% were classified with VFN. (Shah et al., 2005). A study of 312 children previously diagnosed with dysphonia revealed that 82.4% (n=257) of children aged between eight and fourteen years of age presented with significant structural changes to their VF. (Angelillo et al., 2008). Moreover, not only can paediatric voice disorders perpetuate into adulthood but negative perceptions have been found regarding a child's physical appearance, personality and cognitive skills when they are perceived as having a voice problem, particularly VFN (Verduyckt, Remacle, Jamart, Benderitter, & Morsomme, 2011). Not until recently did research direct itself to investigating the related factors that may either cause or contribute to hyperfunctional vocal habits that may manifest in vocal fold anomalies.

Only five recent studies, albeit small sample sizes, have explored the relationship between hyperfunctional vocal habits in children and the presence of ADHD (Hamdan, et al., 2009; Garcia-Real, et al., 2013; D'Alatri, et al., 2015; Erdur, et al., 2016; Barona-Lleo & Fernandez, 2016). It has been reported that children with ADHD are more prone to engage in ADHD-related phonotraumatic behaviours than control group peers (Hamdan, et al., 2009). Authors performed perceptual and acoustic vocal analyses on all participants. The results demonstrated that in a sample of 38 children, 50% of the children with ADHD (n=19) were perceived to be more hoarseness and breathy than the controls. Additionally, 31.6% of the same

children were louder than controls. Consequently, early identification and assessment of vocal characteristics in children with ADHD is necessary (Allen, Bernstein, & Chait, 1991; Hamdan, et al., 2009) Phonotraumatic behaviours may lead to concentrated swelling or submucal bleeding; changing the size, weight, and the range of motion and elasticity of the VF or the subsequent emergence of functional voice disorders (Hamdan, et al., 2009). It was found that children with ADHD demonstrated more vocal symptoms and hyperfunctional behaviours factors related to dysphonia (Garcia-Real, et al., 2013). Acoustically, children with ADHD had less periodic laryngeal vibration resulting in higher % jitter values, lower minimal intensity and tone averages (Garcia-Real, et al., 2013). Authors recommended that future research within this population should include laryngoscopic evaluations to investigate the relationship between hyperfunctional acoustic voice assessment results and the presence of organic laryngeal pathologies (Hamdan, et al., 2009; Garcia-Real, et al., 2013).

Similarly, D'Alatri et al conducted a study with 38 children of which 47% (n=18) children with VFN scored higher on parent- and teacher-reported ADHD evaluation-related questionnaires than their age-gender matched peers without VFN. These questionnaires are specifically designed to identify ADHD symptoms according to the DSM-IV. Despite a small sample size, authors postulated that ADHD may be an associated risk factor in the development of hyperfunctional voice disorders that may manifest in VFN (D'Alatri, et al., 2015). More recently, in a study including 78 children authors reported that over 86% of children with ADHD (n=67) presented with mild to severe dysphonia (Barona-Lleo & Fernandez, 2016). Thirty two of the 44 children with ADHD could be explored laryngoscopically. Seventy eight percent of these children with ADHD (n=25) had clinically significant changes to the anatomy of their VF, most commonly VFN. Given the proposed high prevalence of VFN in the school-aged population with ADHD, the chronicity of ADHD and the added risk of comorbid conditions, any effort to ameliorate or reduce the effect of subsequent disorders or difficulties of ADHD should be made efficiently and effectively (Chorozoglou, Smith, Koerting, Sayal, & Sonuga-Barke, 2015; Vrba, et al., 2016).

Significantly higher disease/disorder prevalence rates are coupled with increased primary health-related costs (Cohen, Kim, Roy, Asche, & Courey, 2012). Such costs incurred by families and society in treating and raising children with ADHD are

excessive. A recent study reported that the annual cost per child with ADHD in the United States can reach up to $17 458 (approximately R250 000) per annum (Barona-Lleo & Fernandez, 2016). The medical treatment and educational support required due to ADHD's chronicity and comorbidity may be a lifelong expense (Chorozoglou, et al., 2015). In the event that associated laryngeal injuries are identified in children with ADHD, effective management necessitates medical and speech-language intervention (Ramig & Verdolini, 1998; Shah et al., 2005). This inflates the costs incurred by the families of these children even further. In South Africa, as in other low and middle income countries (LMICs,) the reality remains that families from LSES with children with ADHD simply do not have the means to afford or access such services (Vrba, et al., 2016).

The proposed predisposition that children with ADHD have for laryngeal injuries are recurrent in nature and are more often than not overlooked as laryngitis (Barona-Lleo & Fernandez, 2016; Hamdan et al., 2009). Surgical intervention can be prevented if subversive hyperkinetic behaviours are addressed early enough. Voice therapy remains the primary preventative treatment measure to date for children with laryngeal injuries (Mori, 1999; Şenkal & Çiyiltepe, 2013).

Recalling that several studies have reported varied results on the prevalence rates of paediatric VFN within the school-aged population with and without ADHD, the use of different vocal characteristic parameters, factoring in past-misdiagnoses and/or delayed appropriate ENT and speech-language therapy referrals and the negative impact thereof, warrants further investigation into this population's vocal parameters. Consequently, the following research question is posed: What are the vocal characteristics of school-aged children with and without ADHD?

2. Method

Chapter aim: The chapter expands on the main aim and methods of the study. The study replicated a published protocol, with additions. These additions included the use of a standardized, validated and internationally recognized software program and an objective, multiparametric equation to classify the degree of dyshonia. Data was collected in two parts.The first part of the protocol that all participants underwent was the clinical examination involving laryngeal videostroboscopic visualization to detect changes to the laryngeal anatomy and was collected by a specialist otorhinolaryngologist. The second part involved the perceptual, acoustic and aerodynamic voice assessment conducted by the researcher, a trained SLP. Additionally, the protocol is described in such a way to make replicability of the study possible

2.1. Research aim

The aim of the study was to investigate the laryngeal anatomy, perceptual, acoustic and aerodynamic vocal characteristics of school-aged children with and without ADHD.

2.2. Research design

A static, two group non-experimental comparison was used. This research design was deemed appropriate as i lends itself to addressing the main aim of the current study. Participants were not randomly selected and the independent variable (ADHD or the lack thereof) could not be directly manipulated by the researcher. Additionally, the independent variable categorized the participants into either comparison group by way of experience of the presence or lack of ADHD. The cross-sectional assessment was without treatment for either comparison group prior to assessment. Additionally, the cross-sectional assessment allowed for the comparison of vocal characteristic differences between the groups to be measured in terms of the independent variable (Campbell & Stanley, 1963). Furthermore, any causal or proposed observed relationships between either group were addressed post hoc (Campbell & Stanley, 1963). The study replicated the protocol as executed by Barona-Lleo and Fernandez (2016), with some additions. The additions included the assessment of acoustic vocal parameters through the use of the Multidimensional Voice Program (MDVP) and the Voice Range Profile (VRP) to generate a comparable indicator of dysphonia; namely the dysphonia severity index (DSI).

2.3. Setting

Pretoria Preparatory School is a private remedial school located in Brooklyn, an eastern suburb in Pretoria. The school serves 170 pupils ranging from Grade 0 to 7. For convenience, the assessment protocol designed for the study was conducted at two sites. Clinical examination of the vocal system by the ENT specialist was conducted at the Voice Clinic, Life Groenkloof hospital in Pretoria. The perceptual, instrumental and aerodynamic voice assessment conducted by the researcher took place at the Voice Laboratory, University of Pretoria. Both sites are well-equipped with highly sophisticated materials and the necessary ENT stroboscopic equipment to collect relevant data.

2.4. Participants

Purposive as well as snowball sampling were employed. . This non-probability sampling strategy was used due to the strict inclusion criteria of the study and limited availability of possible candidates. Additionally, the current study required that all participants be assessed, with both professionals, in one session. This further limited the researcher in choosing participants in close proximity to the researching professionals (Etikan, Musa, & Alkassim, 2016). The parents/caregivers of the eligible participants were approached by the student researcher upon permission from Pretoria Preparatory School (PPS) during the period of January to May 2017. A sample of 24 children was obtained for the study, however due to the poor tolerance of laryngeal videostroboscopic examinations of 4 children, only the results of 20 participants were included in the study. The sample was categorized into two groups; namely an ADHD and control group. The ADHD group was sampled using purposive sampling methods to obtain a sample of 10 children with ADHD aged between seven and nine years. The control group was sampled using snowball sampling methods to obtain a sample 10 children (aged between seven and nine years old) with no history of ADHD, good academic progress (no history of academic difficulty) and lower scores than the test group according to the results of the paediatric Voice Handicap Index (pVHI) ($T \geq 1.84$) questionnaire. Both groups had a similar age and gender distribution.

Inclusion criteria for eligible participants are: 1) males and females aged seven to nine years old, 2) attend PPS, 3) children with ADHD would have to have been diagnosed by a paediatric neurologist according to either the DSM-IV-TR or DSM-5 ADHD criteria and taking their prescribed medication, 4) all participants must pass a hearing screen in order to participate; 5) parents/caregivers of the participants would have to provide informed consent for their participation and 6) children participating would have to provide their assent for their participation.

These inclusion criteria are suggested to be implemented in order for a uniform assessment procedure to be implemented throughout the study as well as to ensure that all possible characteristics of vocal hyperfunction in children aged 7-9 years (with or without ADHD) can be measured. Furthermore, inclusion criteria (5) and (6) are mandatory for ethical reasons.

Exclusion criteria include: 1) physical illness that negates the ability for the child to participate for the full duration of the study. Illnesses or infections that may affect voice production include any upper and/or lower respiratory infections, fevers, nausea and any other diseases that could negatively impact affect vocal quality. A qualified ENT will determine the medical stability of any child who may present with any medical concerns on the day of assessment. No eligible participant with ADHD taking medication or having comorbid conditions would be excluded. However, participants would be asked to disclose this information in their informed consent letter, so as to help the researcher determine the cause of any noticeable but unexplainable vocal parameter anomalies between the groups' results.

2.5. Materials and Procedure

The study consisted of a comprehensive case history questionnaire (Appendix D), parental-proxy rating scales (Appendix E and F), a clinical instrumental examination and the perceptual, acoustic and aerodynamic voice assessment (Appendix G). The entire study duration lasted approximately 45 minutes per participant. The assessment procedures, materials and rationale utilized in the study are discussed below:

Voice assessment protocol

All 20 children (14 males, 6 females) with and without ADHD underwent a once-off, free clinical, perceptual, acoustic and aerodynamic voice assessment.

The clinical examination

For reliable comparability measures, all participants underwent the clinical assessment. The clinical examination was conducted by a qualified ENT specialist. In order to detect or differentially diagnose for the presence of upper respiratory illnesses and voice disorders, a videostroboscopic examination of the anatomy and functioning of the upper airways was conducted. A RLS 9100B strobe unit by KayElemetrics Corp was used. Depending on each participant's tolerance, either a rigid or flexible scope was used; namely an ENT VNL 1170K or an ENT SN 9108 scope. The assessment consisted of a physical examination of each participant as well as minimally invasive indirect laryngoscopy to examine the larynx and VFs. The clinical assessment took a total of 15 minutes. To obtain consensus across diagnoses, a second ENT specialist reassessed the stroboscopic examination recordings of 25% of participants. The ENT was not aware of the age, gender or the ADHD status of any participant reassessed. Interrater reliability was determined and interpretations have been deemed reliable as one hundred percent consensus was obtained between the physicians.

The perceptual, acoustic and aerodynamic voice assessment

The complete voice assessment (Appendix G) was conducted by the researcher at the Voice Laboratory at the University of Pretoria. A comprehensive case history questionnaire was given to all the participants' parents. To ensure the reliability of the absence of an ADHD diagnosis amongst control group participants, parents were asked to complete the Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS) (Appendix F) (Wolraich et al., 2003). Parents of all participants were asked to complete the validated and reliable, 23-item paediatric Voice Handicap Index (PVHI); assessing the impact of dysphonia on a paediatric population (Veder et al., 2017). A cut-off point of 7 or less was considered asymptomatic (Veder et al., 2017).

The widely accepted GRBASI 4-point scale (Yamauchi, Imaizumi, Maruyama, & Haji, 2010) was employed during the perceptual assessment of participants' voices using a spontaneous speech sample. Picture-based speech sample stimuli were used to

control for the reading ability of all participants. Consensus of the GRBASI results obtained by the researcher was achieved by means of a panel of qualified speech language pathologists with experience in voice therapy. The diagnosis of ADHD of each participant's recordings was unknown to the panel members. Majority consensus was reached through independent scoring in a quiet room, of all 20 samples in free-field, in one session. Fifty percent of the samples were repeated for validity purposes. After independent scoring of the samples, results were compared and discussed.

The maximum phonation time (MPT) of all participants was measured using the steady state vowel /a/ upon maximum inspiration and the best time over three repetitions were recorded (Table 3.3). MPT was considered normal when greater than or equal to 7.98 seconds (Dejonckere. , 2010).

Thereafter, an s/z ratio was calculated by producing the voiceless /s/ and voiced /z/ on maximal inspiratory effort for as long as possible. The best of three attempts was recorded (Table 3.3).

Aerodynamic assessment reveals information regarding phonatory efficiency (Dejonckere, 2009) and was carried out using a Contec DATASpiro digital spirometer (SASPRSP10W). The aerodynamic parameter investigated was Forced Vital Capacity (FVC). Forced Vital Capacity (FVC) measures were analyzed using the digital spirometer and recorder through a software program (Table 3.3). Theoretical models suggested that a predicted FVC of 1,4 -1,6L (girls) and 1,4 – 1,8L (boys) was to be considered as normal for children aged seven to nine years old (Orlikoff & Baken, 1993)

Multidimensional Voice Program Analysis (MDVP) and the Voice Range Profile (VRP) of the Computerized Speech Lab (CSL) (MODEL 4105B; KayPENTAX) was conducted on all the participants in a sound-proof room. Data was processed, recorded and stored on a Mecer Prelude Intel Pentium Dual Core desktop computer. Acoustic analysis of the voice was executed using a microphone set at a fixed off-axis position of 45° and 10cm away from their mouths. The MDVP was used to evaluate the jitter (*jitt%)*, shimmer (*shim%)*, fundamental frequency variation (vF_0) and noise-to-harmonics ratios (NHR) of each participant (Table 3.3). The VRP is a

depiction of one's minimum and maximum volume and pitch capacities across one's vocal range.

A Dysphonia Severity Index (DSI), a multi-parametric tool, was employed to generate an objective vocal quality score based on acoustic results. A score was then generated using the Maximum Phonation Time (MPT in seconds), highest frequency (Hz), lowest intensity (dB) and jitter (%). Although paediatric normative data is not yet available for the DSI; the index was used in a descriptive manner. Adult norms indicate that a DSI of >0 as normal and a DSI of <0 to -5 as either mild, moderately or severely dysphonic. Likewise, for our study population, a DSI of >0 was classified as normal and <0 to -2 was considered as dysphonic. These norms were used as a guideline (Yu, Ouaknine, Revis, & Giovanni, 2001).

The variables assessed in the perceptual, acoustic and aerodynamic voice assessment are described below in Table 2.1.

The perceptual, acoustic and aerodynamic voice assessment lasted approximately 25 to 30 minutes.

Table 2.1: Description of the Aerodynamic and Acoustic Assessment Parameters

Parameter	Description
Forced vital capacity (FVC) in mL	The expiratory capacity of the human lungs following maximal inspiratory effort (Irzaldy, Wiyasihati, & Purwanto, 2015).
Maximum phonation time (MPT) in s	The maximum duration of the steady state vowel /a/ upon maximal inspiration; indicating the respiratory, aerodynamic and myoelastic regulation involved in voice production (Speyer, et al., 2010; Mendes Tavares, Brasolotto, Rodrigues, Benito Pessin, & Garcia Martins, 2012).
Phonation quotient (PQ) in mL/s	PQ is a clinically valuable ratio in monitoring laryngeal pathology as it assesses the rate of air flow with regards to phonatory efficiency by way of predictable vocal fold motion. It is a reliable measurement tool in determining the nature of suspected vocal pathology and managing treatment outcomes (Dejonckere, 2010; Mendes Tavares, Brasolotto, Rodrigues, Benito Pessin, & Garcia Martins, 2012).
S/Z ratio	The s/z ratio is a widely accepted, indirect measurement evaluating glottal closure with the potential of cautioning professionals of possible laryngeal pathologies in patients. Normal voice production should reflect an s/z ratio nearer to1.0 (Gelfer & Pazera, 2006; Mendes Tavares, et al., 2012)
Jitter (%)	Jitter percentage is a computerized value measuring the frequency changes between the periods of consecutive cycles divided by the mean period. It is a valuable perceptual perturbation measure in evaluating voice quality (Dejonckere, 2010)
Shimmer (%)	Shimmer percentage is a computerized value assessing the short-term variations in amplitude of cycle-to-cycle vocal fold vibrations (Dejonckere, 2010).
Fundamental frequency (vF_0) (%)	Fundamental frequency variation demonstrates the standard deviation of the fundamental frequency changes over the whole analysed voice sample (Campisi, Tewfik, Pelland-Blais, Husein, & Sadeghi, 2000).
Noise-harmony ratio (NHR) in dB	As an adjunct to perceptual assessment of voice, NHR evaluates the amount of additive noise to speech signal as a result of aperiodic vocal fold vibration or incomplete glottal closure (Ferrand, 2000). It is a reliable, robust measurement in predicting dysphonia in individuals (Dejonckere, 2010).
Highest intensity in dB	The highest perceived amplitude, or loudness, during phonation.
Lowest intensity in dB	The lowest perceived amplitude or reduction in loudness, during phonation.
Highest frequency in Hz	The highest perceived pitch, or vibratory cycles per second, during phonation.
Lowest frequency in Hz	The lowest perceived pitch during phonation.
Dysphonic Severity Index (DSI)	A multivariate algorithm summating the perceptual, aerodynamic and acoustic results of an individual as an indication of overall voice quality (Wuyts, et al., 2000): $DSI = 0.13\,(MPT) + 0.0053 \times F_0(high) - Intensity\,(low) - 1.18 \times Jitt(\%) + 2.4$

2.6. Data processing and analysis

Data from the questionnaire, parent-reported rating scales, and clinical, perceptual, acoustic and aerodynamic voice assessments were processed and coded into a quantitative form and thereafter captured in Excel. Descriptive statistics was employed through the use of Statistic Package Social Sciences (SPSS) v 23 (Chicago, Illinois). Due to the small sample sizes of the test and control groups the interpretation of results are to be regarded as descriptive and not conclusive. In statistics, when the sample size is sufficiently large, the normality assumption is not needed since the central limit theorem ensures approximate normality (Field, 2013). Due to the small sample sizes of this study, the Kolmogorov-Smirnov test was run on each variable to find whether the data is normally distributed or not (Field, 2013). For the variables where the normality assumption was met, an independent t-test was conducted in order to detect significant differences between the means across the acoustic assessment results (Field, 2013). Additionally, a Levene's test was run prior to the t-test to assess whether the data set had equal or unequal variances (Field, 2013). For the variables where the normality assumption was not met, a nonparametric method, the Mann-Whitney test, was performed. The Mann-Whitney test is the nonparametric counterpart to the parametric t-test (Field, 2013). Cross-tabulations were conducted in order to investigate any significant associations between the perceptual, acoustic and respiration assessment results and the clinical findings. A p value <0.05 was deemed significant. Instrumental data from the clinical examination performed by an ENT, the responses from open ended questions in the parental questionnaires and rating scale forms (pVHI) was thematically analysed by the researcher to further describe and comment on observed vocal phenomena.

2.7. Validity and reliability

Validity is the extent to which an instrument evaluates what it was designed to measure (Leedy & Ormrod, 2014). By working with highly calibrated instrumentation and within a sound-proof voice laboratory, the researcher increased the validity of data collected. Both content and criterion validity measures were taken in the research study. This was ensured by using standardized, validated measurement tools pVHI and VAPRS and GRBASI. The pVHI was developed from the validated Voice Handicap Index (VHI) for adults (Jacobson, et al., 1997) and found to have

good internal consistency and test—retest reliability for dysphonia in the paediatric population (Zur et al., 2007). The VADPRS is a clinically useful, cost-effective tool found to have good internal consistency, an acceptable factor structure and was reliable in identifying ADHD as prescribed by the DSM-IV and other accepted ADHD-scales (Wolraich et al., 2003). The GRBASI is a widely accepted perceptual tool that was deemed reliable and validated across multiple settings, compared against similar tools and in various languages (Hirano, Hibi, Terasawa, & Fujiu, 1986; Dejonckere, Obbens, De Moor, & Wieneke, 1993; Giovanni et al., 1996; De Bodt, Wuyts, Van de Heyning, & Croux, 1997; Yu et al., 2001). A cross-check principle was conducted between the questionnaire, parent-proxy rating scales and objective clinical, perceptual, aerodynamic and acoustic measures to see if the results obtained revealed any correlations. Inter-rater validity measures were taken to obtain consensus of the GRBASI by the student researcher and a panel of qualified speech therapists. A double-blind inter-rater validity measure was conducted with another specialist ENT to establish consensus validity regarding the laryngoscopic examination results obtained by the research specialist ENT.

Reliability is the ability of an instrument to yield measurements that are specific and consistent across multiple repetitions (Leedy & Ormrod, 2014). Reliability measures taken by the researcher and ENT specialist include the use of calibrated instrumentation, and the above-mentioned measurement tools and scales that have been validated and standardized. Additionally, both professionals are well trained in the field of voice disorders, are able to converse in the language of learning and teaching (LoLT) in the research population. Furthermore, test-retest reliability was employed by both the specialist ENT and SLP in that 40% of the examinations were repeated at random and findings were found to be consistent across each repetition.

2.8. Research ethics

Special considerations must be taken when conducting clinical research within vulnerable populations, especially in children. Ethical guidelines and considerations must be employed to ensure that the rights of children are upheld, the high standards of optimal health care and provision are met and the overall safety and wellbeing of children and their families are maintained (Modi, et al., 2014). The study strove to abide by the following ethical principles:

Ethical clearance and permission to conduct research

Ethical clearance was obtained from the Research and Ethics Committee of the Faculty of Humanities and the Department of Speech-Language Pathology and Audiology of University of Pretoria prior to data collection (Appendix A). Permission to conduct research was sent to PPS to identify and invite parents and their children who meet the inclusion criteria to participate in the study (Appendix B).

Autonomy and Informed consent

All the participant's parents/caregivers were given an informed consent letter in which all the relevant information regarding the study was made available (Appendix C). It was emphasised that parents/caregivers and participants were allowed to withdraw their participation from the study at any time, without reason and negative consequences.

Beneficence

Parents and participants were informed of the potential benefit they may receive from the study. Assessment and identification of any vocal pathology would result in the necessary referrals for intervention and appropriate support thereto. Parents/caregivers and the participants would become more knowledgable in self-detecting and monitoring of hyperfunctional vocal habits, receive general guidance in vocal hygiene practices and environmental modifications to prevent voice disorders.

Non-maleficence

Research participants were not in any way subject to physical or psychological injury, stress or embarrassment. The families of participants and the participants themselves were respected at all times. An experienced ENT specialist and a qualified trained speech language therapist collected the data. To prevent any undue harm or traumatic exposure to the participants, children were allowed to withdraw from undergoing the laryngeal stroboscopic examination at any point in time during the assessment.

Confidentiality

Confidentiality measures that were employed in the study included assigning a number to each participant. This measure was taken to ensure each participant's right to privacy and identity protection. Dissemination of any data was presented with the same numbers and was subject to the written permission from the parent/caregivers of the participant.

2.9. Proposed contribution

The paucity in research regarding the hyperfunctional voice disorders presenting in children with ADHD, results in limited awareness of appropriate management and support for families who may not otherwise be able to afford and/or access the appropriate intervention services. This can result in lifelong barriers to people within this population and costs incurred by a developing countries' already overburdened primary- and school-health related services. If the specific vocal characteristics and aerodynamic parameters of hyperfunctional voice disorders can be identified early enough in children with ADHD, increased advocacy can be garnered in order to prevent voice disorders as well as any associated laryngeal pathology from developing.

This study aimed to describe the vocal characteristics presenting in school-aged children with ADHD in South Africa. Thus, by raising awareness regarding the pervasive impact of ADHD on underdeveloped laryngeal mechanisms, there is hope to reduce the prevalence of VFN and costs incurred in treating the disease by way of advocating for the necessary and timeous services these children may need.

3. Vocal characteristics of school-aged children with and without attention deficit hyperactivity disorder

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3.1. Abstract

Summary: Objective. The aim of this study was to describe the laryngeal anatomy, perceptual, acoustic and aerodynamic vocal characteristics of school-aged children with and without ADHD. The predisposition that children with ADHD have for laryngeal injuries are recurrent in nature and are more often than not overlooked as laryngitis. Previous studies have reported varied results on the prevalence rates of paediatric vocal fold nodules (VFN) within the school-aged ADHD population.

Study Design.
A static, two-group comparison was used in the study to investigate the clinical, perceptual, acoustic and aerodynamic vocal characteristics of children between 7 and 9 years old with and without ADHD.

Methods. The study replicated the protocol as executed by Barona-Lleo and Fernandez (2016) with additions. The Multidimensional Voice Program (MDVP) and the Voice Range Profile (VRP) as additions to the assessment of vocal parameters were used with which comparable dysphonia severity index (DSI) scores were calculated. Once-off clinical, perceptual, acoustic and aerodynamic voice assessments were conducted on 20 age-gender matched participants (Control group mean age (months) = 98.80, SD=10.379; ADHD group mean age (months) = 108.00, SD= 10.873). It was hypothesized that children with ADHD would have more

[1] This article was edited in alignment as per the editorial requirements stipulated by the journal and may differ from the editorial style of the rest of this dissertation document.

hyperfunctional vocal characteristics; leading to laryngeal injuries, than their control group peers.

Results. 45% (n=9) of the total sample population (both groups combined) had laryngeal pathology. Similar parent reported etiological voice symptoms and vocal habits were seen across both groups. Both groups performed similarly across both perceptual and aerodynamic voice assessments. Acoustically, the control group achieved significantly higher producible pitches than the ADHD group (p=0.028) and were found to have more dysphonic DSI scores than their ADHD group peers (p=0.034).

Conclusion. Prepubertal, school-aged children with or without ADHD may have similar vocal characteristics than previously thought. This is in support of the null hypothesis. The authors of the current study recommend that vocal screening in all school-aged children be carried out as an effective measure to monitor voice disorders in the paediatric population. Future research into larger sample sizes with this population with a special focus on the effect that CNS stimulants may have on the voice is recommended.

Key Words: Paediatric voice disorders; Attention deficit hyperactivity disorder; vocal fold nodules; Dysphonia Severity Index; Multidimensional Voice Program; Voice Range Profile

3.2. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is the single most common heterogeneous paediatric psychiatric disorder [1]. Internationally the prevalence of ADHD in primary school children is estimated between five to eight percent. [2,3,4,5] In South Africa, a recent clinical audit at the Red Cross War Memorial Hospital reported that the prevalence rate of paediatric ADHD was 8.5%. [6]

A number of predisposing factors play a role in the high prevalence of the disorder and leave people, from low and middle income households, vulnerable to ADHD. [7] The majority of people in South Africa are classified as having a low socioeconomic status (LSES) and are often at a greater risk for ADHD and its associated comorbid psychiatric illnesses.[6] Factors that play a role in the high prevalence of ADHD include decreased school enrolment, the level of parental education, parental mental health status, familial conflict and structure, being male, perinatal consumption of/exposure to toxins (especially tobacco and/or alcohol), difficulties during childbirth, brain injury as well as HIV/AIDS. [7,6]

Approximately 60% of children with ADHD experience other significant comorbid impairments. [8,9,20,11] These impairments include, amongst others, substantial speech-language and social communication difficulties. Such impairments may limit social interaction in subversive ways. [12,13,14] A child may overexert their voice, also known as talkativeness, a hyperkinetic behaviour common in children with ADHD. [15] “Talking too much” coupled with reduced self-monitoring of emotional reactions, communicative intent, and nonverbal cues may lead to high-pitched, rapid rates of talking at uncomfortable intensity levels which inflict phonotrauma onto laryngeal structures. [12,16,17] Consequently, these phonotraumatic behaviours can be further exacerbated by excessive laryngeal and extra-laryngeal muscle tension and may lead to voice problems with or without vocal fold nodules (VFN).

Only a few studies have reported on the prevalence of VFN in the paediatric population in general. [19,25,35] Much variance in the incidence of VFN in school-aged children has been reported in previous research [19]. The majority of other studies investigated children with pathological voice characteristics. In 2008, authors reported that 82.4% (n=257) of children aged between eight and fourteen years presented with significant structural changes to their VF.[35] Although previously

reported incidence rates were as low as 1% and as high as almost 23.4%, authors recommend that 6-9% should be considered more realistic. [19] In a Turkish study, the reported prevalence of VFN in school-aged children was found to be 16.9%. [19] In contrast, 82% of children previously diagnosed with dysphonia aged between eight and fourteen years of age presented with significant structural changes to their VF.[35] Not until recently did research direct itself to investigating the related factors that may either cause or contribute to hyperfunctional vocal habits that may manifest in laryngeal pathology.

Only five recent studies, albeit with small sample sizes, have explored the relationship between hyperfunctional vocal habits in children and the presence of ADHD. [15,12,21,16,20] It has been reported that children with ADHD presented with increased loudness, were more hoarse and breathy than their control peers. [15] As a result, early identification and assessment of vocal characteristics in children with ADHD is necessary [12, 15]. Phonotraumatic behaviours may lead to concentrated swelling or submucosal bleeding; changing the size, weight, the range of motion and elasticity of the VF or the subsequent emergence of functional voice disorders. [15] Conversely, inattentive and or hyperactive/impulsive behaviours most commonly associated with ADHD were higher in children with VFN. [12,21] It was recommended that future research should include laryngoscopic evaluation in this population to investigate the presence of organic laryngeal pathologies. [15,12,21] Authors postulated that ADHD may be an associated risk factor in the development of hyperfunctional voice disorders that may manifest in VFN.[21] Moreover, the parental report results from the Conners' Parent Rating Scale-Revised: Short Form (CPRS-RS) indicated that children with VFN presented with more hyperactive and oppositional behaviours than their control group peers.[16] Recently, another study reported that over 90% of children with ADHD presented with hyperfunctional vocal behaviours. Seventy eight percent of these children with ADHD (n=25) had clinically significant changes to the anatomy of their VF, most commonly VFN [20]. Bearing in mind that due to its chronicity, ADHD often persists into adulthood and coupled with the increased risk of having comorbid conditions, any effort to ameliorate or reduce the effect of subsequent disorders or difficulties of ADHD should be made efficiently and effectively. [6,23],

Higher disease/disorder prevalence rates are proportional to increased primary health-related costs.[22] The annual cost per child with ADHD in the United States can reach over $17 000 (R250 000) per annum. [20] The medical treatment and educational support required due to ADHD's chronicity and comorbidity may be a lifelong expense. [23] If ADHD-related laryngeal injuries are identified in children, effective management necessitates medical and speech-language intervention. [24, 25] This inflates the costs incurred by their families. The reality remains that, for people from low and middle-income countries (LMICs) and LSES and other related risk factors that predispose them to ADHD, they simply cannot afford or access such services [6].

The predisposition that children with ADHD have for laryngeal injuries are recurrent in nature and are more often than not overlooked as laryngitis. [20, 15] Voice therapy remains the primary preventative treatment measure to date for children with laryngeal injuries. [26, 27] Previous studies have reported variability in the prevalence rates of VFN in school-aged children with ADHD and thus merit further investigation. [12,15,16,19,20,21] As a result, the following research question is posed: What are the vocal characteristics of school-aged children with ADHD?

3.3. Method

3.3.1. Aim

The aim of the study was to describe the laryngeal anatomy, perceptual, acoustic and aerodynamic vocal characteristics of school-aged children with and without ADHD. It was hypothesized that children with ADHD would have more hyperfunctional vocal characteristics; leading to laryngeal injuries, than their control group peers.

3.3.2. Research design

A static, two-group comparison was used in the study to investigate the clinical, perceptual, acoustic and aerodynamic vocal characteristics of children between 7 and 9 years old with and without ADHD.

Ethical clearance was obtained through the Faculty of Humanities Research Ethics Committee at the University of Pretoria on February 2017 (Ref: *GW20170116HS*)

3.3.3. Participants

Convenience sampling was employed to obtain a sample of 24 children who agreed to participate in this study. However, the results of only twenty participants could be included in the study due to poor tolerance of the videostroboscopic examination. Remaining participants were categorized into two groups, aged between 7 and 9 years old. The ADHD group comprised of 10 children with ADHD and the control group had 10 children with no history of ADHD. This was confirmed by the outcome of the Vanderbilt ADHD Diagnostic Parent Rating Scale (VDPRS) and no reported academic difficulties. The groups had a similar age and gender distribution. Participants were required to be aged between seven to nine years old in order to control for the pubertal-vocal differences in fundamental frequencies (F_0) found across conversational speech. [30,31,32,33,34] The ADHD diagnosis of the ADHD group participants had to be made by a paediatric neurologist according to either the DSM-IV-TR or DSM-V ADHD criteria. ADHD group participants had to be actively taking their prescribed medication. Participants were excluded if they presented with any chronic medical condition as well as intellectual developmental, neurological and/or sensory disabilities. A qualified Ear, Nose and Throat (ENT) specialist conducted a thorough physical examination on all participants.

3.3.4. Voice assessment protocol

Permission was obtained from school authorities and parents, or guardians from all participants. All 20 children (14 males, 6 females) with and without ADHD underwent a once-off, free clinical, perceptual, acoustic and aerodynamic voice assessment.

3.3.4.1. The clinical examination

For reliable comparability measures, all participants had to undergo the clinical assessment. The clinical examination was conducted by a qualified ENT specialist. In order to detect or differentially diagnose for the presence of upper respiratory illnesses and voice disorders, a videostroboscopic examination of the anatomy and functioning of the upper airways was conducted. A RLS 9100B strobe unit by KayElemetrics Corp was used. Depending on each participant's tolerance, either a rigid or flexible scope was used; namely an ENT VNL 1170K or an ENT SN 9108 scope. The assessment consisted of a physical examination of each participant as

well as minimally invasive direct video laryngoscopy to examine the larynx and VFs. The clinical assessment took a total of 15 minutes. To obtain consensus across diagnoses, another qualified ENT specialist reassessed the stroboscopic examination recordings of 25% of participants. The ENT was not aware of the age, gender or the ADHD status of any participant reassessed. Diagnosis was made based on normal vocal fold, oedema or the presence of vocal fold nodules. Interrater reliability has been determined and interpretations have been deemed reliable as one hundred percent consensus was obtained between the physicians.

3.3.4.2. The perceptual, acoustic and aerodynamic voice assessment

The complete voice assessment was conducted by the researcher at the Voice Laboratory at the University of Pretoria. A comprehensive case history questionnaire was given to all the participants' parents, which included a checklist of hyperfunctional vocal characteristics (Table 3.1) to best describe their child's voices. To ensure the reliability of the absence of an ADHD diagnosis amongst control group participants, parents were asked to complete the Vanderbilt ADHD Diagnostic Parent Rating Scale [53]. Parents of all participants were asked to complete the validated and reliable, 23-item paediatric Voice Handicap Index (pVHI); assessing the impact of dysphonia on a paediatric population [38]. A cut-off point of 7 or less was considered asymptomatic. [39]

The widely accepted and validated GRBASI 4-point scale [40] was employed during the perceptual assessment of participants' voices using a spontaneous speech sample. Picture-based speech sample stimuli were used to control for the reading ability of all participants. Consensus of the GRBASI results obtained by the researcher was achieved by means of a panel of qualified speech language pathologists with experience in voice therapy. The diagnosis of ADHD of each participant's recordings was unknown to the panel members. Majority consensus was reached through independent scoring in a quiet room, of all 20 samples in free-field, in one session. Fifty percent of the samples were repeated for validity purposes. After independent scoring of the samples, results were compared and discussed.

The maximum phonation time (MPT) of all participants was taken using the steady state vowel /a/ after maximum inspiration and the best time over three repetitions were recorded. MPT was considered normal when greater than or equal to 7.98 seconds [41].

Thereafter, an s/z ratio was calculated by producing the voiceless /s/ and voiced /z/ on maximal inspiratory effort for as long as possible. The best of three attempts was recorded.

Aerodynamic assessment reveals information regarding phonatory efficiency [42] was carried out using a Contec DATASpiro digital spirometer (SASPRSP10W). The aerodynamic parameter investigated was Forced Vital Capacity (FVC). Forced Vital Capacity (FVC) measures were analyzed using the digital spirometer and recorder through a software program. Theoretical models suggested that a predicted FVC of 1,4 - 1,6L (girls) and 1,4 – 1,8L (boys) was to be considered as normal for children aged seven to nine years old [42].

Multidimensional Voice Program Analysis (MDVP) and the Voice Range Profile (VRP) of the Computerized Speech Lab (CSL) (MODEL 4105B; KayPENTAX) was conducted on all the participants in a sound-proof room. Data was processed, recorded and stored on a Mecer Prelude Intel Pentium Dual Core desktop computer. Acoustic analysis of the voice was executed using a microphone set at a fixed off-axis position of 45° and 10cm away from the mouth. The MDVP was used to evaluate the jitter (*jitt %)*, shimmer (*shim %)*, fundamental frequency variation (vF_0) and noise-to-harmonics ratios (NHR) of each participant. The VRP is a depiction of one's minimum and maximum volume and pitch capacities across one's vocal range.

A Dysphonia Severity Index (DSI), a multi-parametric tool, was employed to generate an objective vocal quality score based on acoustic results. A score was then generated using the Maximum Phonation Time (MPT in seconds), highest frequency (Hz), lowest intensity (dB) and jitter (%). Although paediatric normative data is not yet available for the DSI; the index was used in a descriptive manner. Adult norms indicate that a DSI of >0 as normal and a DSI of <0 to -5 as either mild, moderately or severely dysphonic. Likewise, for our study population, a DSI of >0 was classified as normal and <0 to -2 was considered as dysphonic. These norms were used as a guideline. [45]

The perceptual, acoustic and aerodynamic voice assessment lasted 25 to 30 minutes. The duration of the entire protocol was 45 to 60 minutes.

3.3.5. Data analysis

Descriptive statistics were employed through the use of Statistic Package Social Sciences (SPSS) v 23 (Chicago, Illinois). Due to the small sample sizes of the ADHD and control groups, the interpretations of results are to be regarded as descriptive and not conclusive. The Kolmogorov-Smirnov test was run on each variable to determine the normality of the distribution [44]. A Levene's test was employed to evaluate whether the data seta had equal or unequal variances [44]. An independent t-test was conducted where the normality assumption was met, in order to detect for significant differences between the groups' acoustic means (Jitter % , Shimmer % , F0, NHR, Highest dB, Lowest dB, F-Hi and F-Lo) [44]. Where the normality assumption was not met, the Mann-Whitney test, the nonparametric equivalent of the independent t-test, was executed [44]. Cross-tabulations were conducted, by means of a Pearson Chi-square test in order to investigate any significant correlations between the perceptual, acoustic and respiration assessment results and the clinical findings [44]. A significance level of < 0.05 was considered as significant for all analyses.

3.4. Results

The ADHD and control group were similar in terms of age ($p = 0.069$) and gender distribution. In this study, both groups comprised of seven males and three females. In the ADHD group, only six of the ten participants were on prescribed medication; namely Ritalin, Concerta or Strattera.

According to the case history questionnaire, six parental reports of children with ADHD reported experiencing at least three or more etiological vocal symptoms. Four parents of children within the control group also reported vocal symptoms that indicated hyperfunction. Overall, half of the total population sample reported hyperfunctional vocal symptoms (n=10) (Table 3.1).

Table 3.1: Summary of the parental responses of the vocal etiological symptoms checklist of participants (n=20)

Variable	Basic Themes	ADHD group (n=10)	Control group (n=10)	Total (n=20)
Pitch quality	*Normal*	6	6	12
	Too high	2	1	3
	Too low	2	3	5
Volume perception	*Normal*	4	6	10
	Too loud	3	0	3
	Too soft	3	4	7
Overall vocal quality *(can report more than one)*	*Normal*	5	6	11
	Monotonous	3	0	3
	Control issues	0	3	3
	Nasal	1	1	2
	Hoarse/Harsh	1	2	3
	Breathy	2	1	3
Breathing as a factor to voice problem	*Yes*	2	1	3
	No/Not applicable	8	9	17
Child awareness of voice problem	*Yes*	2	2	4
	No/Not applicable	8	8	16
The effect their voice has on their everyday life	*None*	9	9	18
	Significant	0	1	1
	Moderate	1	0	1

Interestingly, seven (mean = 8.3; SD = 11.08) of the total sample population were found to have abnormal pVHI scores. Similar parent-reported pVHI scores of participants, indicating hyperfunction, were found among both groups [Control (n= 4): mean= 9.2, SD= 4.3; ADHD (n= 3): mean= 7.4, SD= 13.6; p=0.328].

After analysing the clinical examinations of the laryngeal anatomy of all participants, it was found that 9 out of the total 20 participants had some anatomical change to their VF. Both groups were found to laryngeal pathology; namely oedema (ADHD n=2; Control n=1), bilateral pre-nodules (ADHD n=3) and bilateral VFN (Control n=3). More interestingly, 35% (n=7) of the same participants who were found to have a laryngeal pathology also had abnormal pVHI scores (p= 0.002) and DSI scores indicative of possible dysphonia (p= 0.020). A significant difference was also seen

between the pVHI and DSI scores (p= 0.035) over the total sample population. This may indicate that the pVHI may have been more accurate in detecting vocal concerns prior to the perceptual, acoustic and aerodynamic assessment of the participants' voices. When evaluating the scores of the GRBASI (Table 3.2), similar results were seen in both groups across the six categories of perceptual voice quality.

Table 3.2: Frequency distribution of GRBASI scores (n=20)

GRBASI	Condition	Normal *(score = 0)*	Slight *(score = 1)*	Moderate *(score = 2)*	p-value
G	ADHD (n=10)	7	1	2	0.684
	Control (n=10)	5	4	1	
	Total (n= 20)	12	5	3	
R	ADHD (n=10)	7	2	1	0.971
	Control (n=10)	7	2	1	
	Total (n= 20)	14	4	2	
B	ADHD (n=10)	3	5	2	0.143
	Control (n=10)	5	3	2	
	Total (n= 20)	8	8	4	
A	ADHD (n=10)	8	2	0	0.529
	Control (n=10)	8	2	0	
	Total (n= 20)	16	4	0	
S	ADHD (n=10)	8	2	0	0.684
	Control (n=10)	8	1	1	
	Total (n= 20)	16	3	1	
I	ADHD (n=10)	9	1	0	0.739
	Control (n=10)	9	0	1	
	Total (n= 20)	18	1	1	

- *Significance level: $p < 0.05$*

The acoustic assessment results (Table 3.3) revealed that there was a significant difference between the two groups in terms of the overall DSI score (p=0.034) and the F-low (p=0.028) of participants. In both instances, the control group had more

dysphonic DSI scores and achieved lower F-low results than ADHD group peers. The ADHD group achieved lower means in jitter and shimmer and a higher variation in their fundamental frequencies than control group peers. Although not statistically significant (p=0.091), the ADHD group participants had a higher VC (mean= 1746mL; SD= 439) than control group participants (mean= 1403mL; SD= 420.3). This was in alignment with the higher MPT scores (p=0.500) in the ADHD group participants (mean= 15.2s; SD= 5.8) when compared to control group peers (mean= 13.5s; SD= 5.3). Almost identical mean values were found in the NHR and s/z ratio scores for both groups (ADHD mean= 13.5s; SD= 5.8; control mean= 15.2s; SD= 5.3; p= 0.877).

Table 3.3: Comparison of the Aerodynamic and Acoustic Assessment Results between children with and without ADHD.

Acoustic Parameter	Group	Mean	SD	p-value
MPT (s)	ADHD (n= 10)	15.2	5.8	
	Control (n=10)	13.5	5.3	0.500
	Overall (n=20)	14.4	5,5	
VC (mL)	ADHD (n= 10)	1746.0	439.0	
	Control (n=10)	1403.0	420.3	0.091
	Overall (n=20)	1574.5	453,8	
PQ (mL/s)	ADHD (n= 10)	129.6	57.6	
	Control (n=10)	116.0	50.9	0.583
	Overall (n=20)	122.7	53,4	
Jitter (%)	ADHD (n= 10)	1.3	0.5	
	Control (n=10)	1.5	1.0	0.514
	Overall (n=20)	1.4	0,8	
Shimmer (%)	ADHD (n=	4.6	2.0	
	Control (n=10)	5.0	2.2	0.705
	Overall (n=20)	4.8	2,0	
Fundamental frequency variation (%)	ADHD (n= 10)	2.0	0.6	
	Control (n=10)	1.8	0.8	0.530
	Overall (n=20)	1.9	0,7	
NHR (dB)	ADHD (n= 10)	0.1	0.02	
	Control (n=10)	0.1	0.02	0.877
	Overall (n=20)	0.1	0.0	
s/z	ADHD (n= 10)	0.8	0.02	
	Control (n=10)	0.8	0.02	0.968
	Overall (n=20)	0.8	0,2	
Highest dB (dB)	ADHD (n= 10)	97.9	7.5	
	Control (n=10)	99.8	4.2	0.819
	Overall (n=20)	98.9	6,0	

Lowest dB (dB)	ADHD (n= 10)	68.1	6.4	
	Control (n=10)	74.6	9.5	0.089
	Overall (n=20)	71.4	8.5	
F-High (Hz)	ADHD (n= 10)	718.4	191.2	
	Control (n=10)	630.2	169.7	0.290
	Overall (n=20)	674.3	181.7	
F-low (Hz)	ADHD (n= 10)	110.8	52.6	
	Control (n=10)	170.1	58.5	0.028*****
	Overall (n=20)	140.5	62.1	
DSI	ADHD (n= 10)	0.4	4.5	
	Control (n=10)	-3.2	2.3	0.034*****
	Overall (n=20)	-1.4	3.9	

- *Significance level: $p < 0.05$*

3.5. Discussion

Thirty percent (n=6) of the total sample population were found to have VFN. Similar prevalence rates of VFN have been reported in large cohort studies conducted in a general school-age population where the prevalence ranged between 15-35%. [50,19] In contrast, in an early retrospective review of almost 18 000 paediatric cases, only 4% (n=731) of patients were classified with a laryngeal pathology of which 17.5% (n=128) were predominantly VFN. [51] In the current study VFN diagnosis in male participants outnumbered that in females by an even larger 5:1 ratio. Similar findings were reported where males outnumbered females in prevalence of VFN diagnosis by a 2:1 ratio. [19] Acoustically, the overall means of the jitter (1.4%, SD=0.8), shimmer (4.8%, SD=2.0), fundamental frequency variation (1.9%, SD=0, 7), NHR (0.1 dB, SD=0.0), F-high (674.3 Hz, SD=181.7) and F-low (140.5 Hz, SD=62.1) in the current study were similar to the findings reported by Campisi et al [53]. Interestingly, in the current study the F-low in the ADHD group was significantly lower than among controls (p= 0.028). Variations in previous findings may be due to differences in research methodology used, i.e. sampling strategies, small sample sizes and the voice criteria used to determine dysphonia. [19]

Previous findings reported that children with ADHD were at risk for developing voice disorders as almost half of the participants with ADHD were breathier, louder and hoarser than control peers. [12, 15] In the current study, 40% of the total sample population, i.e. children with and without ADHD, were identified with the same hyperfunctional voice symptoms. Acoustically, there was no significant difference between the jitter (p=0.514) or the speaking volumes of either groups which is in

contrast to previous findings. [12,15,20,52] The current study demonstrated that there were equal rates in the incidence of VFN amongst control and ADHD group participants. Previous authors showed that more than 90% (n=30) of children with ADHD had anatomical changes to their VF and that 78% (n=25) of these changes were classified as VFN. [20] They recommended voice assessment, by relevant medical professionals and speech therapists, as part of the holistic management of children with ADHD due to the possibility that ADHD may be a risk factor in paediatric dysphonia. The authors of the current study support these recommendations, due to the fact that school-aged children with or without ADHD were found to have similar vocal characteristics with equal propensity towards incurring laryngeal injuries.

In the current study the ADHD group achieved significantly lower pitch levels (110.8 Hz) than their control group peers (170.1 Hz) (p=0.028). This may be due to the fact that central nervous system (CNS) stimulants may indirectly and as a secondary effect lower the F0 in the voices of children with ADHD to counteract the hyperfunctional vocal behaviours that may cause voice problems. [47, 48] However, not much research has been conducted in investigating the effect of CNS stimulants on voice production, much less in children. [47, 48] Therefore future research should explore the effect of medication on the vocal characteristics of children with ADHD.

Both the ADHD and control group presented with similar outcomes in the aerodynamic, the acoustic and the parent-reported etiological voice symptoms and vocal habits of their children. It was apparent to the authors that the pVHI, although lengthier than the parental vocal etiological symptoms checklist, was somewhat easier to understand and rate without prior orientation to, education and training in good voice production. However, of the 9 participants identified with laryngeal changes, only 4 participants' pVHI scores were abnormal, with or without ADHD. Laryngeal pathology diagnoses were seen in participants whose parents rated on the checklist to have been more talkative, loud, harsh manner of talking and having high pitched voices. Taking into consideration that 45% of the sample population (n=9) were diagnosed with a laryngeal pathology, it is cumbersome that parent-proxy reports (the vocal etiological symptom checklist or pVHI) failed to identify these children prior to their clinical examination. Previous authors argue that parent-proxy questionnaires may under detect dysphonia in children, even when guiding

instructions are provided, and is most often associated with insufficient knowledge or training regarding good vocal hygiene and use. [12,47] This discrepancy highlights the importance of using multidimensional methods in paediatric voice assessments, advocating the need for greater awareness creation regarding good voice habits and supporting parents of children at risk for developing childhood voice disorders. Additionally, the need for the support of parents in understanding healthy voice production prior to rating their children's voices will aid in more accurately screening children before subjecting them to full voice assessment.

3.6. Limitations and recommendations

The largest limitation of the current study is our small sample size. Strict study criteria, access to the specified population, recruitment of participants that matched study criteria, consent and availability of parents and participants were factors that determined our sample size. Although the current study did have a small sample size, the current study is time and cost efficient for future research to expand to larger sample sizes.

Furthermore, the possible secondary effect that CNS stimulants used in treating paediatric ADHD has on voice production and use, justifies for further research into this population. In our study, participants differed in terms of the type of medication, dosage, duration on the type of medication, as well as adherence and attitudes towards the treatment plan. To ensure that representative vocal differences, or lack thereof, are detected, future research utilizing larger sample populations is recommended. As a precaution, stricter control should be employed with regards to medication type, dosage and duration.

Moreover, voice production is highly sophisticated, thus a, wide array of parameters were required in order to detect changes at each level of voice production. Measurements investigated in the current study, as part of a replicated voice protocol from recent research, are based on internationally accepted standards in the assessment of voice. [20]

Additionally, as a whole the results are valuable particularly in a population where normative values are scarce; consequently adding to a growing body of research. It is recommended that the MDVP, VRP and spirometry be used to assess vocal

characteristics in this population for the holistic value the data sets play as well as their time and cost efficiency. Further research is recommended into larger populations so as to establish paediatric norms for the DSI, as it quantifies the degree of severity of dysphonia and is useful as a means of tracking progress when speech therapy is employed as an adjunct therapy.

Finally, the results of this study supports previous findings in which the pVHI should be included in the screening of paediatric voice problems as it was more likely to detect dysphonia in participants identified with laryngeal changes in the current study. In addition, parent education and training in normal voice production should be given prior to scoring parent-proxy questionnaires or voice-related quality of life scales. This may curb the effect that was seen in the under-detection of voice-related problems in children from parent-proxy reports used as a means of voice screening.

3.7. Conclusion

In conclusion, the current study confirmed that despite a small sample size, a significant amount of school-age children were prone to developing voice problems whether or not they may have ADHD. This is in support of the null hypothesis. This study highlights the importance of screening all school-aged children to ensure early detection of possible voice problems and to intervene when necessary. Furthermore, efforts to increase parental awareness of the importance of good vocal habits are evident. Further research is warranted within a larger sample size of this population, with a new direction in investigating the effect of the pharmacological management of ADHD on the paediatric voice.

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3.9. Disclosure Statement

The authors have no conflicts of interest to declare.

3.10. References

1. Division of Human Development and Disability, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention. (2016, April 29). Facts about ADHD. Retrieved March 21, 2016, from Centers for Disease Control and Prevention: http://www.cdc.gov/ncbddd/adhd/facts.html

2. Polanczyk G, Lima MS de, Horta BL, Biederman J, Rohde LA. The Worldwide Prevalence of ADHD: A Systematic Review and Metaregression Analysis. 2007;(June):942-948.

3. Polanczyk G V., Willcutt EG, Salum GA, Kieling C, Rohde LA. ADHD prevalence estimates across three decades: An updated systematic review and meta-regression analysis. Int J Epidemiol. 2014;43(2):434-442. doi:10.1093/ije/dyt261.

4. Ercan E, Kandulu R, Uslu E, et al. Prevalence and diagnostic stability of ADHD and ODD in Turkish children: a 4-year longitudinal study. Child Adolesc Psychiatry Ment Health. 2013;7(1):30. doi:10.1186/1753-2000-7-30.

5. Thomas R, Sanders S, Doust J, Beller E, Glasziou P. Prevalence of Attention-Deficit/Hyperactivity Disorder: A Systematic Review and Meta-analysis. Pediatrics. 2015;135(4):e994-e1001. doi:10.1542/peds.2014-3482.

6. Vrba K, Vogel W, de Vries PJ. Management of ADHD in children and adolescents: clinical audit in a South African setting. Journal of Child & Adolescent Mental Health. 2016 Apr 29;28(1):1-9.

7. Bakare M. Attention deficit hyperactivity symptoms and disorder (ADHD) among African children: a review of epidemiology and co-morbidities. Afr J Psychiatry. 2012;15(5):358-361. doi:http://dx.doi.org/10.4314/ajpsy.v15i5.45.

8. Ercan ES, Kandulu R, Uslu E, Ardic UA, Yazici KU, Basay BK, Aydın C, Rohde LA. Prevalence and diagnostic stability of ADHD and ODD in Turkish children: a 4-year longitudinal study. Child and adolescent psychiatry and mental health. 2013 Dec;7(1):30.

9. Gillberg C. Perceptual, motor and attentional deficits in Swedish primary school children. Some child psychiatric aspects. Journal of Child Psychology and Psychiatry. 1983 Jul 1;24(3):377-403.

10. Jensen P, Martin D, Cantwell D. Comorbidity in ADHD: implications for research, practice, and DSM-V. J Am Acad Child Adolesc Psychiatry. 1997;36(8):1065-1079.

11. Zorlu A, Unlu G, Cakaloz B, Zencir M, Buber A, Isildar Y. The Prevalence and Comorbidity Rates of ADHD Among School-Age Children in Turkey. J Atten Disord. 2015;1(9). doi:10.1177/1087054715577991.

12. Garcia-Real T, Diaz-Roman TM, Garcia-Martinez V, Vieiro-Iglesias P. Clinical and acoustic vocal profile in children with attention deficit hyperactivity disorder. J Voice. 2013;27(6):787.e11-787.e18. doi:10.1016/j.jvoice.2013.06.013.

13. Bishop DV, Baird G. Parent and teacher report of pragmatic aspects of communication: use of the Children's Communication Checklist in a clinical setting. Developmental Medicine and Child Neurology. 2001 Dec;43(12):809-18.

14. Geurts HM, Verte S, Oosterlaan J, et al. How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? J Child Psychol Psychiatry Allied Discip. 2004;45(4):836-854. doi:10.1111/j.1469-7610.2004.00276.x.

15. Hamdan A-L, Deeb R, Sibai A, Rameh C, Rifai H, Fayyad J. Vocal characteristics in children with attention deficit hyperactivity disorder. J Voice. 2009;23(2):190-194. doi:10.1016/j.jvoice.2007.09.004.

16. Erdur O, Herguner A, Ozturk K, et al. Attention deficit hyperactivity disorder symptoms in children with vocal fold nodules. Int J Pediatr Otorhinolaryngol. 2016;85(April):5-7. doi:10.1016/j.ijporl.2016.03.017.

17. Roy N. Functional dysphonia. Curr Opin Otolaryngol Head Neck Surg. 11(3):144-148. doi:10.1097/00020840-200306000-00002.

18. Van Houtte E, Van Lierde K, Claeys S. Pathophysiology and treatment of muscle tension dysphonia: A review of the current knowledge. J Voice. 2011;25(2):202-207. doi:10.1016/j.jvoice.2009.10.009.

19. Akif Kiliç M, Okur E, Yildirim I, Güzelsoy S. The prevalence of vocal fold nodules in school age children. Int J Pediatr Otorhinolaryngol. 2004;68(4):409-412. doi:10.1016/j.ijporl.2003.11.005.

20. Barona-Lleo L, Fernandez S. Hyperfunctional Voice Disorder in Children with Attention Deficit Hyperactivity Disorder (ADHD). A Phenotypic Characteristic? J Voice. 2016;30(1):114-119. doi:10.1016/j.jvoice.2015.03.002.

21. D'Alatri L, Petrelli L, Calò L, Picciotti PM, Marchese MR, Bussu F. Vocal fold nodules in school age children: Attention deficit hyperactivity disorder as a potential risk factor. J Voice. 2015;29:287-291. doi:10.1016/j.jvoice.2014.07.019.

22. Cohen SM, Kim J, Roy N, Asche C, Courey M. Direct health care costs of laryngeal diseases and disorders. Laryngoscope. 2012;122(7):1582-1588. doi:10.1002/lary.23189.

23. Chorozoglou M, Smith E, Koerting J, Thompson MJ, Sayal K, Sonuga-Barke EJ. Preschool hyperactivity is associated with long-term economic burden: evidence from a longitudinal health economic analysis of costs incurred across childhood, adolescence and young adulthood. Journal of Child Psychology and Psychiatry. 2015 Sep 1;56(9):966-75.

24. Ramig LO, Verdolini K. Treatment efficacy: voice disorders. Journal of Speech, Language, and Hearing Research. 1998 Feb 1;41(1):S101-16.

25. Shah RK, Woodnorth GH, Glynn A, Nuss RC. Pediatric vocal nodules: correlation with perceptual voice analysis. Int J Pediatr Otorhinolaryngol. 2005;69(7):903-909.

26. Mori K. Vocal fold nodules in children: preferable therapy. International journal of pediatric otorhinolaryngology. 1999 Oct 5;49:S303-6.

27. Şenkal Ö, Çiyiltepe M. Effects of voice therapy in school-age children. J Voice. 2013;27(6). doi:10.1016/j.jvoice.2013.06.007.28.

29. Guimarães MF, Behlau MS, Panhoca I. Perceptual analysis of adolescents' vocal stability during different phonation tasks. Pró-Fono Rev Atualização Científica. 2010;22(4):455-458. doi:10.1590/S0104-56872010000400016.

30. McAllister A, Sjölander P. Children's voice and voice disorders. Semin Speech Lang. 2013;34(2):71-79. doi:10.1055/s-0033-1342978.

31. Kuhn MA. Histological changes in vocal fold growth and aging. Curr Opin Otolaryngol Head Neck Surg. 2014;22(6):460-465. doi:10.1097/MOO.0000000000000108.

32. Wang Y, Liang F, Yang J, Zhang X, Liu J, Zheng Y. The Acoustic Characteristics of the Voice in Cochlear-Implanted Children: A Longitudinal Study. J Voice. 2017;31(6):773.e21-773.e26. doi:10.1016/j.jvoice.2017.02.007.

33. Sales NJ, Gurgel RQ, Gonçalves MIR, et al. Characteristics and Professional Use of Voice in Street Children in Aracaju, Brazil. J Voice. 2010;24(4):435-440. doi:10.1016/j.jvoice.2008.12.007.

34. Angelillo N, Di Costanzo B, Angelillo M, Costa G, Barillari MR, Barillari U. Epidemiological study on vocal disorders in paediatric age. J Prev Med Hyg. 2008;49(1):1-5.

35. Hirano M. Clinical examination of voice. Disorders of human communication. 1981;5:1-99.

36. Allen KD, Bernstein B, Chait DH. EMG biofeedback treatment of pediatric hyperfunctional dysphonia. J Behav Ther Exp Psychiatry. 1991;22(2):97-101. doi:10.1016/0005-7916(91)90004-O.

37. Zur KB, Cotton S, Kelchner L, Baker S, Weinrich B, Lee L. Pediatric Voice Handicap Index (pVHI): A new tool for evaluating pediatric dysphonia. Int J Pediatr Otorhinolaryngol. 2007;71(1):77-82. doi:10.1016/j.ijporl.2006.09.004.

38. Veder L, Pullens B, Timmerman M, Hoeve H, Joosten K, Hakkesteegt M. Reliability and validity of the Dutch pediatric Voice Handicap Index. Int J Pediatr Otorhinolaryngol. 2017;96:15-20. doi:10.1016/j.ijporl.2017.02.023.

39. Yamauchi EJ, Imaizumi S, Maruyama H, Haji T. Perceptual evaluation of pathological voice quality: A comparative analysis between the RASATI and GRBASI scales. Logopedics Phoniatrics Vocology. 2010 Oct 1;35(3):121-8.

40. Mendes Tavares EL, Brasolotto AG, Rodrigues SA, Benito Pessin AB, Garcia Martins RH. Maximum phonation time and s/z ratio in a large child cohort. J Voice. 2012;26(5):3-6. doi:10.1016/j.jvoice.2012.03.001.

41. Dejonckere P. Assessment of voice and respiratory function. Surg Larynx Trachea. 2009:11-26. doi:10.1007/978-3-540-79136-2.

42. Orlikoff RF, Baken RJ. Clinical speech and voice measurement: Laboratory exercises. Singular Publishing Group; 1993.

43. Field A. Discovering Statistics Using IBM SPSS Statistics.; 2013.

44. Pebbili GK, Kidwai J, Shabnam S. Dysphonia Severity Index in Typically Developing Indian Children. J Voice. 2017;31(1):125.e1-125.e6. doi:10.1016/j.jvoice.2015.12.017.

45. Yu P, Ouaknine M, Revis J, Giovanni A. Objective voice analysis for dysphonic patients: A multiparametric protocol including acoustic and aerodynamic measurements. J Voice. 2001;15(4):529-542. doi:10.1016/S0892-1997(01)00053-4.

46. Tavares ELM, Brasolotto A, Santana MF, Padovan CA, Martins RHG. Epidemiological study of dysphonia in 4-12 year-old children. Braz J Otorhinolaryngol. 2011;77(6):736-746. doi:10.1590/S1808-86942011000600010.

47. Lufi D. The Effect of Methylphenidate on speech patterns of children with Attention Deficit Disorder. J Behav Heal. 2013;2(3):252. doi:10.5455/jbh.20130224082901.

48. Congologlu MA, Turkbay T, Ciyiltepe M, Durukan I, Dogangun B, Yuce M. Immediate effects of methylphenidate on vocal acoustic parameters in children with attention deficit hyperactivity disorder. Bull Clin Psychopharmacol. 2009;19(4):365-372. http://www.scopemed.org/?mno=3094.

49. Hirschberg J, Dejonckere P, Hirano M, Mori K, Schultz-Coulon H, Vrtička K. Symposium: Voice disorders in children. Int J Pediatr Otorhinolaryngol. 1995;32:109-125. doi:10.1016/S0031-3955(05)70523-X.

50. Pannbacker M. Treatment of vocal nodules: options and outcomes. American Journal of Speech-Language Pathology. 1999 Aug 1;8(3):209-17.

51. Dobres R, Lee L, Stemple JC, Kummer AW, Kretschmer LW. Description of laryngeal pathologies in children evaluated by otolaryngologists. Journal of Speech and Hearing Disorders. 1990 Aug 1;55(3):526-32.

52. Campisi P, Tewfik TL, Pelland-Blais E, Husein M, Sadeghi N. MultiDimensional Voice Program analysis in children with vocal cord nodules. J Otolaryngol. 2000;29(5):302-308. http://www.ncbi.nlm.nih.gov/pubmed/11108490.

53. Wolraich ML, Lambert W, Doffing MA, Bickman L, Simmons T, Worley K. Psychometric properties of the Vanderbilt ADHD diagnostic parent rating scale in a referred population. Journal of pediatric psychology, 28(8). 2003;: p. 559-568.

4. Discussion and Conclusion

Chapter aim: The aim of this chapter is to discuss and provide a summation of the research findings. A critical evaluation of the research is provided and recommendations for future research opportunities are given.

4.1. Discussion of results

Data was collected over two weeks, in collaboration with a specialist ENT. To the best of our knowledge, the current study is the first to incorporate the DSI. It was used as a means of quantifying voice problems in children with ADHD in tandem with previously used measures, i.e. the MDVP, VRP and a clinical examination of laryngeal structures.

Prevalence of laryngeal pathology

Thirty percent (n=6) of the total sample population, i.e. children with and without ADHD, were found to have VFN. Similar prevalence rates of VFN have been reported in large cohort studies conducted in the US and Turkey in the general school-age population where the prevalence rates ranged between 15-35% (Pannbacker, 1999; Kiliç et al., 2004). In contrast, in an early retrospective review of almost 18 000 paediatric cases, only 4% (n=731) of patients were classified with a laryngeal pathology of which 17.5% (n=128) were predominantly VFN (Dobres, Lee, Stemple, Kummer, & Kretschmer, 1990). In the current study, VFN diagnosis in male participants outnumbered that in females by an even larger 5:1 ratio. Similar findings were reported where males outnumbered females in prevalence of VFN diagnosis by a 2:1 ratio (Kiliç et al., 2004). Much variance in the incidence of VFN in school-aged children has been reported in previous research (Kiliç et al., 2004). Variations may have been due to differences in research methodology used, i.e. sampling strategies and sizes as well the criteria used to delineate vocal characteristics assessed. The majority of other studies only investigated children with pathological voice characteristics (Kiliç et al., 2004).

Acoustic vocal characteristics

Acoustically, there was no significant difference between the jitter (p=0.514) or the speaking volumes of either groups in the current study which is in contrast to previous findings (Campisi et al., 2000; Hamdan et al., 2009; Garcia-Real et al., 2013; Barona-Lleo & Fernandez, 2016). The overall means of the jitter (1.4%, SD=0.8), shimmer (4.8%, SD=2.0), fundamental frequency variation (1.9%, SD=0, 7), NHR (0.1 dB, SD=0.0), F-high (674.3 Hz, SD=181.7) and F-low (140.5 Hz, SD=62.1) in the current study were similar to the findings reported by Campisi et al (2000). Interestingly, in the current study the F-low in the ADHD group was significantly lower than among controls (p= 0.028). Furthermore, the ADHD group achieved significantly lower pitch levels (110.8 Hz) than their control group peers (170.1 Hz) (p=0.028). This may be due to the fact that central nervous system (CNS) stimulants may indirectly and as a secondary effect lower the F0 in the voices of children with ADHD to counteract the hyperfunctional vocal behaviours that may cause voice problems (Congologlu et al., 2009; Lufi, 2013). However, not much research has been conducted in investigating the effect of CNS stimulants on voice production, much less in children (Congologlu et al., 2009; Lufi, 2013). Therefore future research should explore the effect of medication on the vocal characteristics of children with ADHD.

The co-occurrence of hyperfunctional vocal symptoms in children with ADHD

Recent literature has now been directed at the effect that ADHD may have on the voices of school-aged children. Garcia-Real et al. (2013) demonstrated that children with ADHD were more predisposed to engaging in phonotraumatic vocal behaviours that resulted in a greater prevalence of hyperfunctional voice habits than their control group peers, as almost half of the participants with ADHD were breathier, louder and hoarser (Hamdan et al., 2009; Garcia-Real et al., 2013). In the current study, 40% of the total sample population were identified with the same hyperfunctional vocal symptoms from parental report (i.e. more talkative, loud, harsher manner of talking and having high pitched voices).

4.2. Clinical implications

Both the control and ADHD group presented with similar outcomes in the aerodynamic, acoustic and parent-reported etiological voice symptoms and vocal

habits of their children. Taking into consideration that 45% of the sample population (n=9) were diagnosed with a laryngeal pathology, it is concerning that parent reports failed to identify these children prior to their clinical examination. Previous authors argue that the chronicity of childhood dysphonia may result in the poor perception of parents and their ability to detect voice problems (Martins et al., 2012). Other authors suggest that parent- questionnaires may under detect dysphonia in children, even when guiding instructions are provided, and is most often associated with insufficient knowledge or training regarding good vocal hygiene and use (Tavares et al., 2011; Garcia-Real et al., 2013). This discrepancy highlights the importance of using multidimensional methods in paediatric voice assessments, advocating the need for greater awareness creation regarding good voice habits and supporting parents of children at risk for developing childhood voice disorders.

As part of school health services, voice screening is recommended for all school-aged children. The pVHI has been found to be valid and easy to use in many languages and contexts internationally and is a vital tool in identifying potential voice problems in the paediatric population. However, parental education and support on healthy voice usage and good vocal hygiene should be given prior to parent-proxy voice screenings in the form of awareness campaigns and parent information sessions. This allows for parents and/or caregivers to clarify any terms or concepts used in the forms prior to completing voice screening. With the recent advancement in screening technology in the field of speech-language pathology and audiology, digital educational videos can be created as a nationwide effort to educate and train parents of school-aged children. Furthermore, digitizing voice screening is an area that future research should explore for time and cost efficiency, as paper-based screening was most often reported as time-consuming for parents in our study.

The current study demonstrated that there were equal rates in the incidence of VFN amongst control and ADHD group participants. Previous research showed that more than 90% (n=30) of children with ADHD had anatomical changes to their VF and that 78% (n=25) of these changes were classified as VFN (Barona-Lleo & Fernandez, 2016). Voice assessment was recommended, by relevant medical professionals and speech therapists, as part of the holistic management of children with ADHD due to the possibility that ADHD may be a risk factor in paediatric dysphonia. The current study supports these recommendations, due to the fact that school-aged children

with or without ADHD were found to have similar vocal characteristics with equal propensity towards incurring laryngeal injuries.

4.3. Critical evaluation

A critical evaluation of the current study is required to assess the strengths and limitations of the research conducted.

Strengths of the study

To the best of the researcher's knowledge, this is the first study to report that school-aged children, with or without ADHD, are more likely to have similar propensity towards incurring laryngeal injuries than previously believed. It is the first study, albeit a small sample size, to report similar VFN prevalence rates found in larger international cohort studies investigating school-aged children as a whole. This advocates for the screening, at the very least, of all school-age children for dysphonia, as dysphonias may perpetuate beyond childhood and can negatively impact education and socialization.

The study made use of a replicated protocol, being the first to date to incorporate the use of the DSI as a measure to objectively quantify the degree of vocal hyperfunction in children. The advantage of a previously published protocol, with additions, is that it aids in the reliability of the study. Making use of additions justified the replication as new parameters could be explored to investigate if a difference between the voices of children with or without ADHD may be present.

Notably, a wide array of parameters was required in order to detect vocal differences between the two groups. Due to the sophistication of voice production, the voice assessment evaluated each level of voice production. Measurements investigated in the current study, as part of a replicated voice protocol from recent research, were based on internationally accepted standards in the assessment of voice (Barona-Lleo & Fernandez, 2016). Additionally, as a whole the results are valuable particularly in a population where normative values are scarce; consequently adding to a growing body of research. It is recommended that the MDVP, VRP and spirometry be used to assess vocal characteristics in this population for the holistic value the data sets play as well as their time and cost efficiency. Further research is recommended into larger populations so as to establish paediatric norms for the DSI,

as it quantifies the degree of severity of dysphonia and is useful as a means of tracking progress when speech therapy is employed as an adjunct therapy.

This study utilized data triangulation as a means to establish validity; emphasising the need for multiparametric measure testing in the assessment of paediatric voice disorders. Furthermore, the protocol was designed in such a manner that hyperfunction to the voices of participants was as minimal as possible. It further minimized hyperfunction in its efficiency by the use of highly calibrated equipment and objective algorithms, thus deeming data interpretation as objective and efficient. This research proposed a reliable assessment protocol for the comprehensive assessment of paediatric voice disorders, as it was described in a manner that allows for easy replication.

Finally, the results of this study supports previous findings in which the pVHI should be included in the screening of paediatric voice problems as it was more likely to detect dysphonia in participants identified with laryngeal changes in the current study. In addition, parent education and training in normal voice production should be given prior to scoring parent-proxy questionnaires or voice-related quality of life scales. This may curb the effect that was seen in the under-detection of voice-related problem in children from parent-proxy reports used as a means of voice screening.

Limitations of the study

Four limitations were identified. Firstly, the largest limitation of the current study is our small sample size. Strict study criteria, access to the specified population, recruitment of participants that matched study criteria, consent and availability of parents and participants were factors that determined our sample size. Although the current study did have a small sample size, the protocol of the current study is time and cost efficient for future research to expand to larger sample sizes. Secondly, the accuracy of the degree to which the DSI scores of the participants were hyperfunctional cannot be determined in the paediatric population as it was validated in the assessment of adult voice disorders. Thirdly, no universally accepted set of paediatric vocal characteristic norms exists for the MDP or VRP, which makes comparative descriptions, as was the aim of this study, difficult. This may have resulted in the lack of statistical significance values seen across imperative acoustic variables that are otherwise sensitive to vocal hyperfunction. Finally, the possible

secondary effect that CNS stimulants used in treating paediatric ADHD have on voice production and use, justifies for further research into this population. In our study, participants differed in terms of the type of medication, dosage, duration on the type of medication, as well as adherence and attitudes towards the treatment plan. To ensure that representative vocal differences, or lack thereof, are detected, future research utilizing larger sample populations is recommended. As a precaution, stricter control should be employed with regards to medication type, dosage and duration in future research.

4.4. Future research

A number of future research points where brought to focus in light of the findings of the current study.

- Future research is warranted with a larger sample size of this population screening all school-aged children for dysphonia. A well-developed, time and cost efficient voice screener is recommended for development to be used by teachers and parent/s and or caregiver/s, much like the pVHI, for the South African context. Research should be aimed at developing an integrated voice screener that is both more time and cost efficient, easy-to-understand, and freely accessible and form part of the standardized assessment protocol of a trained SLP.
- Future research should be directed into creating ways in which teachers; parent/s and or caregiver/s are trained and supported in understanding healthy voice production and vocal hygiene. Research must strive to understand the difficulties teachers and parent/s or caregiver/s experience when completing parent-proxy questionnaires and rating scales. This would aid the recommendation of the current study to help support teachers, parent/s and or caregiver/s and curb the under-detection of voice concerns in children prior to them being subjected to clinical examination.
- Future research into larger sample sizes is recommended as there are no paediatric norms for the acoustic voice parameters assessed in the MDVP and VRP programs, making it difficult to classify the dysphonia observed. The same is true when considering the DSI. Only adult cut-off values to quantify the severity of

the dysphonia exist. Without paediatric cut-off values, comparative conclusions are difficult to make and further interpret.

- Future research in determining the prevalence of ADHD in the school-aged population in South Africa is recommended. This would aid in assessing the burden of disease to adequately provide health services, especially in LSES communities. Furthermore, ADHD screening programs already developed for children, once validated, should be used to evaluate the trends of disease prevalence or severity against international rates for monitoring.
- Future research efforts should take a new direction in investigating the prevalence of voice problems experienced by the school-aged population with ADHD and the possible effect of the pharmacological management of ADHD on the paediatric voice. This would aid in advocating a stronger presence for speech-language therapy services to be included in the holistic management of children with ADHD.

4.5. Conclusion

In conclusion, the current study confirmed that despite a small sample size, a significant amount of school-age children were prone to developing voice problems whether or not they may have ADHD. This study highlights the importance of screening all school-aged children to ensure early detection of possible voice problems and to intervene when necessary. Moreover, a voice screener should be developed to ensure that more timeous identification of children requiring medical intervention and voice therapy is made. Furthermore, efforts to increase parental awareness of the importance of good vocal habits to aid voice screening are evident.

References

Allen, K., Bernstein, B., & Chait, D. (1991). EMG biofeedback treatment of pediatric hyperfunctional dysphonia. *Journal of behavior therapy and experimental psychiatry*, 22(2), 97-101.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders, 5th edition.* Washington: American Psychiatric Association.

Angelillo, I., Di Costanzo, B., Costa, G., Barillari, M., & Barillari, U. (2008). Epidemiological study on vocal disorders in paediatric age. *Journal of preventive medicine and hygiene, 49(1).*, 1-5.

Bakare, M. (2012). Attention deficit hyperactivity symptoms and disorder (ADHD) among African children: a review of epidemiology and co-morbidities. *African journal of psychiatry, 15(5)*, 358-361.

Barona-Lleo, L., & Fernandez, S. (2016). Hyperfunctional Voice Disorder in Children With Attention Deficit Hyperactivity Disorder (ADHD). A Phenotypic Characteristic? *Journal of Voice*, 114-119.

Bishop, D., & Baird, G. (2001). Parent and teacher report of pragmatic aspects of communication: Use of the Children's Communication Checklist in a clinical setting. *Developmental Medicine & Child Neurology*, 809-818.

Boseley, M., Cunningham, M., Volk, M., & Hartnick, H. (2006). Validation of the pediatric voice-related quality-of-life survey. *Archives of Otolaryngology–Head & Neck Surgery, 132(7)*, 717-720.

Campbell, D., & Stanley, J. (1963). *Experimental and Quasi-Experimental Designs For Research.* Boston: Houghton Mifflin Company.

Campisi, P., Tewfik, T., Pelland-Blais, E., Husein, M., & Sadeghi, N. (2000). MultiDimensional Voice Program analysis in children with vocal cord nodules. *Journal of Otolaryngology-Head & Neck Surgery, 29(5)*, 302.

Carding, P., Roulstone, S., Northstone, K., & Team., &. A. (2006). The prevalence of childhood dysphonia: a cross-sectional study. *Journal of Voice*, 623-630.

Chorozoglou, M., Smith, E., Koerting, J., Sayal, K., & Sonuga-Barke, E. (2015). Preschool hyperactivity is associated with long-term economic burden: evidence from a longitudinal health economic analysis of costs incurred across childhood, adolescence and young adulthood. *Journal of Child Psychology and Psychiatry*, 966-975.

Cohen, S., Kim, J., Roy, N., Asche, C., & Courey, M. (2012). Direct health care costs of laryngeal diseases and disorders. *The Laryngoscope, 122(7)*, 1582-1588.

Congologlu, M., Turkbay, T., Ciyiltepe, M., Durukan, I., Dogangun, B., & Yuce, M. (2009). Immediate Effects of Methylphenidate on Vocal Acoustic Parameters in Children with Attention Deficit Hyperactivity Disorder. *Klinik Psikofarmakoloji Bülteni*, 19, 365-372.

D'Alatri, L., Petrelli, L., Calò, L., Picciotti, P., Marchese, M., & Bussu, F. (2015). Vocal fold nodules in school age children: attention deficit hyperactivity disorder as a potential risk factor. *Journal of Voice*, 287-291.

De Bodt, M., Wuyts, F., Van de Heyning, P., & Croux, C. (1997). Test-retest study of the GRBAS scale: influence of experience and professional background on perceptual rating of voice quality. *Journal of Voice*, 11(1), 74-80.

Dejonckere, P. (1999). Voice problems in children: pathogenesis and diagnosis. *International Journal of Paediatric Otorhinolaryngology*, 311-314.

Dejonckere, P. (2010). Assessment of voice and respiratory function. In M. Remacle, & H. Eckel, *Surgery of larynx and trachea* (pp. 11-26). Berlin Heidelberg: Springer.

Dejonckere, P., Obbens, C., De Moor, G., & Wieneke, G. (1993). Perceptual evaluation of dysphonia: reliability and relevance. *Folia Phoniatrica et Logopaedica*, 45(2), 76-83.

Division of Human Development and Disability, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention. (2016, April 29). *Facts About ADHD*. Retrieved March 21, 2016, from Centers for Disease Control and Prevention: http://www.cdc.gov/ncbddd/adhd/facts.html

Dobres, R., Lee, L., Stemple, J., Kummer, A., & Kretschmer, L. (1990). Description of laryngeal pathologies in children evaluated by otolaryngologists. *Journal of Speech and Hearing Disorders*, 55(3), 526-532.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of Convenience Sampling and Purposive Sampling. A*merican Journal of Theoretical and Applied Statistics*, 5(1), 1–4. http://doi.org/10.11648/j.ajtas.20160501.11

Ercan, E., Rasiha, K., Erman, U., Ulku, A., Kemal, U., Burge, K., et al. (2013). Prevalence and diagnostic stability of ADHD and ODD in Turkish children: a 4-year longitudinal study. . *Child and adolescent psychiatry and mental health, 7(1)*, 1-10.

Erdur, O., Herguner, A., Ozturk, K., Kibar, E., Isurer, C., Bozkurt, M., et al. (2016). Attention deficit hyperactivity disorder symptoms in children with vocal fold nodules. *International Journal of Pediatric Otorhinolaryngology*, 5-7.

Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics, 4th ed. Sage.

Garcia-Real, T., Diaz-Roman, T., Garcia-Martinez, V., & Vieiro-Iglesias, P. (2013). Clinical and acoustic vocal profile in children with attention deficit hyperactivity disorder. *Journal of Voice*, 787e11-787e18.

Gaub, M., & Carlson, C. (1997). Gender differences in ADHD: a meta-analysis and critical review. *Journal of the American Academy of Child & Adolescent Psychiatry*, 1036-1045.

Geurts, H., Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *Journal of child psychology and psychiatry*, 836-854.

Gillberg, C. (1983). Perceptual, motor and attentional deficits in Swedish primary school children. Some child psychiatric aspects. *Journal of Child Psychology and Psychiatry, 24(3)*, 377-403.

Giovanni, A., Robert, D., Estublier, N., Teston, B., Zanaret, M., & Cannoni, M. (1996). Objective evaluation of dysphonia: preliminary results of a device allowing simultaneous acoustic and aerodynamic measurements. *Folia phoniatrica et logopaedica*, 48(4), 175-185.

Hamdan, A., Deeb, R., Sibai, A., Rameh, C., Rifai, H., & Fayyad, J. (2009). Vocal characteristics in children with attention deficit hyperactivity disorder. *Journal of Voice*, 190-194.

Heylen, L., Wuyts, F., Mertens, F., De Bodt, M., Pattyn, J., Croux, C., et al. (1998). Evaluation of the vocal performance of children using a voice range profile index. *Journal of Speech, Language, and Hearing Research, 41(2)*, 232-238.

Hirano, M., Hibi, S., Terasawa, R., & Fujiu, M. (1986). Relationship between aerodynamic, vibratory, acoustic and psychoacoustic correlates in dysphonia. *Journal of Phonetics*, 14(3–4), 445–456.

Hirschberg, J., Dejonckere, P., Hirano, M., Mori, K., Schultz-Coulon, H., & Vrtička, K. (1995). Symposium: Voice disorders in children. *International Journal of Pediatric Otorhinolaryngology, 32*, 109-125.

Jacobson, B., Johnson, A., Grywalski, C., Silbergleit, A., Jacobson, G., Benninger, M., et al. (1997). The voice handicap index (VHI): development and validation. *American Journal of Speech-Language Pathology*, 6(3), 66-70.

Jensen, P., Martin, D., & Cantwell, D. (1997). Comorbidity in ADHD: Implications for Research, Practice, and DSM-V. *Journal of the American Academy of Child & Adolescent Psychiatry*, 1065-1079.

Kahane, J., & Mayo, R. (1989). The need for aggressive pursuit of healthy childhood voices. *Language, Speech, and Hearing Services in Schools, 20(1),*, 102-107.

Kiliç, M., Okur, E., Yildirim, I., & Güzelsoy, S. (2004). The prevalence of vocal fold nodules in school age children. *International Journal of Pediatric Otorhinolaryngology*, 409-412.

Kumar, R. (2011). *Research methodology: A step-by-step guide for beginners. 3rd Edition.* London: SAGE Publications Ltd.

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000). Prevalence and natural history of primary speech and language delay: Findings from a systematic review of the literature. *International Journal of Language & Communication Disorders, 35(2)* , 165-188.

Leedy, P. D., & Ormrod, J. E. (2015). *Practical research: Planning and desing. 11th edition.* England: Pearson.

Leedy, P., & Ormrod, J. (2014). Chapter 4: Planning your research project. In P. Leedy, & J. Ormrod, *Practical Research: Planning and Design (10th Edition)* (pp. 91-96). Essex: Pearson Education Ltd.

Lufi, D. (2013). The Effect of Methylphenidate on speech patterns of children with Attention Deficit Disorder. *Journal of Behavioral Health*, 2(3), 252-258.

Maia, A., Gama, A., & Kümmer, A. (2014). Behavioral characteristics of dysphonic children: integrative literature review. *In CoDAS for the Sociedade Brasileira de Fonoaudiologia.*, 159-163.

Modi, N., Vohra, J., Preston, J., Elliott, C., Van't Hoff , W., Coad, J., et al. (2014). Guidance on clinical research involving infants, children and young people: an update for researchers and research ethics committees. *Archives of disease in childhood*, 99 (887-891).

Mori, K. (1999). Vocal fold nodules in children: preferable therapy. *International journal of pediatric otorhinolaryngology, 49*, 303-306.

Orlikoff , R., & Baken, R. (1993). *Clinical speech and voice measurement: laboratory exercises.* Singular Publishing Group.

Pannbacker, M. (1999). Treatment of vocal nodules: Options and outcomes. *American Journal of Speech-Language Pathology*, 8(3), 209.

Polanczyk, G., de Lima, M., Horta, B., Biederman, J., & Rhode, L. (2007). The worldwide prevalence of ADHD: a systematic review and metaregression analysis. *American Journal of Psychiatry*, 942-948.

Polanczyk, G., Willcutt, E., Salum, G., Kieling, C., & Rohde, L. (2014). ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis. *International journal of epidemiology*, 434-442.

Ramig, L., & Verdolini, K. (1998). Treatment Efficacy Voice Disorders. *Journal of Speech, Language, and Hearing Research, 41(1)*, 101-116.

Rausch, T. (2014). The effect of Methylphenidate-OROS® on the narrative ability of children with ADHD. *Doctoral dissertation*. Pretoria: University of Pretoria.

Rowland, A., Lesesne, C., & Abramowitz, A. (2002). The epidemiology of attention-deficit/hyperactivity disorder (ADHD): a public health view. *Mental retardation and developmental disabilities research reviews*, 162-170.

Roy, N. (2003). Functional dysphonia. *Current Opinion in Otolaryngology & Head and Neck Surgery*, 144-148.

Roy, N., Barkmeier-Kraemer, J., Eadie, T., Sivasankar, M., Mehta, D., Paul, D., et al. (2013). Evidence-based clinical voice assessment: a systematic review. *American Journal of Speech-Language Pathology*, 212-226.

Roy, N., Bless, D., & Heisey, D. (2000). Personality and voice disorders: a multitrait-mulitdisorder analysis. *Journal of Voice*, 521-548.

Şenkal, Ö., & Çiyiltepe, M. (2013). Effects of voice therapy in school-age children. *Journal of Voice, 27(6)*, 19-25.

Shah, R., Woodnorth, G., Glynn, A., & Nuss, R. (2005). Pediatric vocal nodules: correlation with perceptual voice analysis. *International journal of pediatric otorhinolaryngology, 69(7)*, 903-909.

Silverman, E., & Zimmer, C. (1975). Incidence of chronic hoarseness among school-age children. *Journal of Speech and Hearing Disorders*, 211-215.

South African Speech-Language Hearing Association. (2011). *Code of ethics. Ethics and standards committee. .* Braamfontein: SASLHA.

Spencer, T., Biederman, J., Wilens, T., & Faraone, S. (2002). Overview and neurobiology of attention-deficit/hyperactivity disorder. *Journal of Clinical Psychiatry*, 3-9.

Speyer, R. (2008). Effects of voice therapy: a systematic review. *Journal of Voice, 22(5)*, 565-580.

Statistics South Africa. (2016). *Census 2011 Community Profile Databases.* Pretoria: Statistics South Africa.

Tavares, E., Brasolotto, A., Santana, M., Padovan, C., & Martins, R. (2011). Tavares, E. L. M., Brasolotto, A., Santana, M. F., Padovan, C. A., & Martins, R. H. G. Epidemiological study of dysphonia in 4-12 year-old children. *Brazilian journal of otorhinolaryngology*, 77(6), 736-746.

Thapar, A. C. (2013). Practitioner review: what have we learnt about the causes of ADHD? *Journal of Child Psychology and Psychiatry*, 3-16.

Thapar, A., Cooper, M., Eyre, O., & Langley, K. (2013). Practitioner Review: what have we learnt about the causes of ADHD? *Journal of Child Psychology and Psychiatry*, 3-16.

Thomas, R., Sanders, S., Doust, J., Beller, E., & Glasziou, P. (2015). Prevalence of Attention-Deficit/Hyperactivity Disorder: A Systematic Review and Meta-analysis. *Pediatrics*, 994-1001.

Tuzuner, A., Demirci, S., Oguz, H., & Ozcan, K. (2016). Pediatric Vocal Fold Nodule Etiology: What Are Its Usual Causes in Children? *Journal of Voice.*, In Press.

Van Houtte, E., Van Lierde, K., & Claeys, S. (2011). Pathophysiology and treatment of muscle tension dysphonia: a review of the current knowledge. *Journal of Voice.*, 202-207.

Veder, L., Pullens, B., Timmerman, M., Hoeve, H., Joosten, K., & Hakkesteegt, M. (2017). Reliability and validity of the Dutch pediatric Voice Handicap Index. *International Journal of Pediatric Otorhinolaryngology*, 96, 15-20.

Vrba, K., Vogel, W., & de Vries, P. (2016). Management of ADHD in children and adolescents: clinical audit in a South African setting. *Journal of Child & Adolescent Mental Health*, 1-19.

Wilcut, E. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: a meta-analytic review. *Neurotherapeutics*, 490-499.

Wolraich, M., Lambert, W., Doffing, M., Bickman, L., Simmons, T., & Worley, K. (2003). Psychometric properties of the Vanderbilt ADHD diagnostic parent rating scale in a referred population. *Journal of pediatric psychology, 28(8)*, 559-568.

World medical association. (2013). Declaration of Helsinki: Ethical principles for medical research involving human subjects.

Wuyts, F., De Bodt, M., Molenberghs, G., Remacle, M., Heylen, L., Millet, B., et al. (2000). The Dysphonia Severity IndexAn Objective Measure of Vocal Quality Based on a Multiparameter Approach. *Journal of Speech, Language, and Hearing Research*, 796-809.

Yamauchi, E., Imaizumi, S., Maruyama, H., & Haji, T. (2010). Perceptual evaluation of pathological voice quality: A comparative analysis between the RASATI and GRBASI scales. *Logopedics Phoniatrics Vocology, 35(3)*, 121-128.

Yu, P., Ouaknine, M., Revis, J., & Giovanni, A. (2001). Objective voice analysis for dysphonic patients: a multiparametric protocol including acoustic and aerodynamic measurements. *Journal of Voice*, 15(4), 529-542.

Zelcer, S., Henri, C., Tewfik, T. L., & Mazer, B, T., & Mazer, B. (2002). Multidimensional voice program analysis (MDVP) and the diagnosis of pediatric vocal cord dysfunction. *Annals of Allergy, Asthma & Immunology, 88(6)*, 601-608.

Zorlu, A., Unlu, G., Cakaloz, B., Zencir, M., Buber, A., & Isildar, Y. (2015). The Prevalence and Comorbidity Rates of ADHD Among School-Age Children in Turkey. *Journal of attention disorders*, 1-9.

Zur, K., Cotton, S., Kelchner, L., Baker, S., Weinrich, B., & Lee, L. (2007). Pediatric Voice Handicap Index (pVHI): a new tool for evaluating pediatric dysphonia. *International journal of pediatric otorhinolaryngology, 71(1)*, 77-82.

5. Appendices

Appendix A Ethical Application

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

14 February 2017

Dear Prof Vinck

Project:	**Vocal characteristics of school-aged children with attention deficit hyperactivity disorder in a remedial primary school**
Researcher:	**D Moodley**
Supervisor:	**Dr J van der Linde**
Department:	**Speech-Language Pathology and Audiology**
Reference number:	**12042294(GW20170116HS)**

Thank you for the response to the Committee's correspondence of 30 January 2017.

I have pleasure in informing you that the Research Ethics Committee formally **approved** the above study at an *ad hoc* meeting held on 13 February 2017. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

The Committee requests you to convey this approval to the researcher.

We wish you success with the project.

Sincerely

Prof Maxi Schoeman
Deputy Dean: Postgraduate Studies and Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:tracey.andrew@up.ac.za
Kindly note that your original signed approval certificate will be sent to your supervisor via the Head of Department. Please liaise with your supervisor.

Appendix B PPS Permission Letter

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

15 January 2017

Attention: Mrs. Lyn Hill
Therapy Department HOD
Pretoria Preparatory School

Dear Mrs. Hill,

Permission to identify and invite parents and their children from Pretoria preparatory school (aged seven to nine years; with or without ADHD) to participate in a research study

I, Daniella-Taylyn Moodley, am a Masters student from the Department of Speech-Language Pathology and Audiology at the University of Pretoria. I will be conducting a research study titled: 'Vocal characteristics of school-aged children with attention deficit hyperactivity disorder in a remedial primary school context'. The objective of my study is to determine and describe the vocal characteristics of children aged 7-9 years old who have been diagnosed with Attention Deficit Hyperactivity Disorder. Children with ADHD are predisposed to laryngeal injury and timeous intervention can prevent such laryngeal injuries and associated voice disorders. Voice therapy remains the first preventative treatment measure for all children with laryngeal injuries.

Data will be collected by myself as well a highly qualified Ear-Nose and Throat specialist (Dr. Carl Swanepoel) at the Voice Clinic at the Little Company of Mary (Life Groenkloof) hospital in Pretoria.

Design and procedure: A static, two group comparison will be used. An ENT specialist will perform a rapid, standard, minimally invasive clinical examination of the vocal system using indirect laryngoscopy. Data collection by the researcher will involve the assessment of vocal parameters through the use of computer software programs, the Multidimensional Voice Program (MDVP) and the Voice Range Profile (VRP), to generate a comparable dysphonia score through the use of the dysphonia severity index (DSI).

Participants: Parents and/or caregivers of children aged seven to nine years will be approached by the researcher once permission has been obtained. A sample of 24 children will be used. The first group, or group 1, will be a sample of 12 children with ADHD aged between seven and nine years.

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The control or second, group will be a sample of 12 children with no history of ADHD. The participants in group 1 will be age- and gender-matched to their peers in group 2. Participants eligible for the current study would be:

1) Males and females aged seven to nine years old,
2) Attend PPS (test group)
3) Children with ADHD would have to have been diagnosed by a paediatric neurologist according to either the DSM-IV-TR or DSM-5 ADHD criteria and taking their prescribed medication
4) All participants must pass a hearing screen in order to participate;
5) Parents/caregivers of the participants would have to provide informed consent for their participation and
6) Children participating would have to provide their assent for their participation.

Ethical considerations: Ethical clearance will be obtained pending permission from Pretoria Preparatory School. Strict confidentiality will be imposed on the handling of all clinical data and identifying information of participants and their parents/caregivers.

Risk and benefits: There are no associated risks related to the participation in this research study as a highly qualified ENT will be performing all medical procedures and a trained speech-language therapy student will conduct the perceptual and acoustic voice assessments. All clinical examinations executed by the ENT specialist are minimally invasive and children may withdraw at any time without a reason. The identities of all participants and their parents/caregivers, diagnosis, and other assessment results will be kept anonymous.

In order to conduct my research, clinical and background data from the participants and their caregivers will be captured. At no point will these results be presented in a manner in which the participants' or institution's identities would be recognizable neither would it be published for any other reason than research purposes.

Please feel free to contact myself or my research supervisors at any time should you require any further information. Thank you in advance for your time and co-operation.

Yours sincerely,

Daniella-Taylyn Moodley
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Ear-Nose and Throat Specialist
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Professor Barth H.M.E Vinck
HEAD: DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY

Permission to Approach Eligible Participants at Pretoria Preparatory School

I, SHERRILL WAGENAAR., hereby confirm that I was informed by the research student, Daniella-Taylyn Moodley regarding the type, procedure, risks and benefits of the research study: "Vocal characteristics of school-aged children with attention deficit hyperactivity disorder in South Africa". Additionally, I received and comprehend the information regarding the aforementioned research study.

I am fully aware that the data obtained through this research study, will be processed and disseminated solely for the purposes of research (present and future) in a report or scientific article, lecture, conference proceedings or case study format. It was explained to me that the data will be presented in such a way that the learners', as well as their families' identities, will be kept confidential.

Please indicate (by ticking the relevant box) whether you give permission to allow research student, Daniella-Taylyn Moodley to approach parent/caregiver(s) of eligible pupils from Pretoria Preparatory School to partake in the study explained to me.

PLEASE FILL OUT IN BLOCK LETTERS

Name: SHERRILL WAGENAAR.

Signature:

Date: 10/02/17.

Appendix C Informed Consent Letter

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

15 January 2017

Dear Parent/Guardian

PARENT/GUARDIAN INFORMATION HANDOUT AND INFORMED CONSENT LETTER

Title of research study: *Vocal characteristics of school-aged children with attention deficit hyperactivity disorder in a remedial primary school context*

INTRODUCTION

As part of my Master's degree, I am conducting a research study and would like to invite you to volunteer your child to participate in the study. To help you make your decision, this letter has been designed to answer any questions you may have. It is vital that before you make your decision that you understand everything about this study. If you are unhappy about anything mentioned below, please do not provide your consent. If you need additional information or would like to share any concerns, please do not hesitate to contact me or my supervisors. Our details are provided at the end of this letter.

THE PURPOSE OF THIS RESEARCH

I am describing the voice characteristics of children with Attention Deficit Hyperactivity Disorder (ADHD) between the ages of 7 and 9 years old. In order to describe the voice characteristics, children of the same age and gender will be matched to those with ADHD in this study.

Research has shown that over 60% of children with ADHD experience other co-occurring difficulties, such as speech-language and social communication difficulties. As a result, a child with ADHD may overuse their voice, which is also known as talkativeness. This amount of talking tends to happen at loud volumes and speeds which can cause damage to their vocal cords. By allowing your child to participate in the study and having their voices assessed I hope to report on specific vocal characteristics. This allows medical professionals and speech-language therapists to better assist in preventing voice problems from presenting when a problem may arise.

WHO WILL CONDUCT THE ASSESSMENT, WHERE WILL IT OCCUR AND HOW LONG WILL THIS TAKE?

Should you agree to have your child participate in this study, he/she will be one of 24 participants in total. The study will be conducted on a specific day in May 2017 (the specific date will be communicated to you when all participants' informed consents have been received and confirmed).

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Your child would only be expected to take part in a single assessment, free-of-charge assessment split into two parts at two locations.

WHAT?	The clinical examination	The perceptual and acoustic examination
WHO?	Dr. Carl Swanepoel (ENT specialist)	Daniella-Taylyn Moodley (researcher)
WHERE?	The Voice Clinic Little Company of Mary Hospital 50 George Storrar Drive Medical Centre Room 206 Groenkloof Pretoria Tel: 012 4601284 / 012 3467899	Dept. of Speech-Language Pathology & Audiology University of Pretoria Cnr. Lynnwood Road and Roper Street Hatfield South Africa Pretoria Tel: 012 420 2816 / 072 112 8831
WHEN?	To be announced to you personally telephonically, SMS and email.	Same day as clinical examination at LCM
WHAT TO TAKE WITH?	• ID/driver's license • Medical aid card • Questionnaire forms • A toy or book for your child for the waiting room *(Note – consultation is FREE, but your details must be taken for medical-legal reasons)*	• Questionnaire forms • Any report or forms from Dr. Swanepoel
WHAT WILL HAPPEN?	1. Administration (client forms) 2. Fill in questionnaire forms if you have not had the chance to yet 3. Dr will consult with you – make sure to mention any allergies, operations, illnesses your child has had recently or in the past 4. Dr will conduct a quick, physical examination of your child's upper respiratory tract through the mouth. Your child will have to sit still for this examination. Firm, but gentle pressure will be used to hold the tongue and a small camera will be used to look inside the mouth and throat. This is minimally invasive but might be a little uncomfortable. It is a very quick assessment, but you and/or your child are allowed to withdraw at any time without a reason.	1. Respiration dynamics will be assessed. Your child will blow into a machine that will measure their lung's capacity and aerodynamic force. 2. Perceptual assessment is done in conversation and a series of quick voice tasks (s-z ratio, singing through scales, reading a passage) 3. Acoustic measurements are taken during these tasks through computer software. The values will give the researcher an idea if a voice problem might be present.
HOW LONG WILL THIS TAKE?	No longer than 20 minutes. The drive to UP campus is no longer than 9 minutes	No longer than 25 minutes. Hereafter, you are free to go home. A brief report with concluding assessment remarks will be provided to you in the coming weeks post-assessment via email.
Other	A sugar-free treat will be provided for your child at LCM.	Refreshments will be provided for you and your child at UP.

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HAS THIS RESEARCH STUDY GAINED ETHICAL CLEARANCE?

Yes. Ethical clearance was granted by the Faculty of Humanities Research and Ethics Committee.

WHAT ARE MY CHILD'S RIGHTS AS A PARTICIPANT IN THIS STUDY?

Your child is in no way obligated to participate in this study – it is strictly voluntary. Should you choose to participate in the study, you and your child may withdraw without giving a reason at any point. Should you wish to stop at any time, you and your child's rights will still be upheld. Should any data up to the point of your withdrawal be collected, it will be excluded from the study. There will not be any negative consequences at school either.

WILL ANY OF THESE PROCEDURES RESULT IN DISCOMFORT OR INCONVENIENCE?

Your child will not be placed under medical risk as the clinical examination is minimally invasive. It is a simple, indirect assessment of the mouth and throat structures via a camera that may be a little uncomfortable, but very quick. Topical anaesthesia has been provided for your child's comfort if needed. In the questionnaire, you will be asked about any allergies that your child has and what medication they are taking. Please state this during the consultation with Dr. Swanepoel. All assessments followed in the protocol are minimally invasive and adhere to best practice.

WHAT ARE THE RISKS AND BENEFITS OF THIS STUDY?

There are no associated risks related to the participation in this research study. You and your child would benefit from knowing the health status of his/her voice from physical and acoustic-perceptual levels, receive appropriate referrals if necessary and information regarding healthy voice usage to prevent any future voice difficulties.

CONFIDENTIALITY

You and your child's identifying information will be kept strictly confidential. Only the raw data (without your identifying information) and results of the study will be seen by the researcher, her supervisors, and a statistician. All results pertaining to your child will be made available to you. As per the University of Pretoria's policy, results from the study will be stored at the Department of Speech-Language Pathology and Audiology for 15 years.

If you would like your child to participate in this study, kindly sign the included consent forms. Please do not hesitate to contact us should you have any concerns or questions.

Yours sincerely,

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South Africa

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Professor Bart H.M.E Vinck
HEAD: DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY

INFORMED CONSENT FOR PARENTS/GUARDIANS (proxy for minors u/18 years of age) and AUTHORIZATION FOR RELEASE OF PARTICIPANT INFORMATION

I,_____hereby confirm that I was informed by the research student, Daniella-Taylyn Moodley regarding the type, procedure, risks and benefits of the research study: "*Vocal characteristics of school-aged children with attention deficit hyperactivity disorder in a remedial primary school context*". Additionally, I received and comprehend the information within the Parent Information hand-out and the Informed Consent regarding the aforementioned research study.

I am fully aware that the data obtained through this research study, including myself and my child's personal details (date of birth, names, and diagnoses) will be processed and disseminated solely for the purposes of research (present and future) in a report or scientific article format. It was explained to me that the data will be presented in such a way that my and my child's identities will be kept confidential.

I know that I may withdraw my consent for my child's participation in the study at any time and without giving a reason. Sufficient opportunities have been made available to me to clarify any concerns I have regarding the study and its procedures. I voluntarily give permission for my child, _____, to participate in this study.

Please indicate (by ticking the relevant box) whether you give permission to allow for data obtained through this study to be used for present and future research purposes; abiding by strict confidentiality measures.

I, _____ hereby confirm that the results from this study may be used in present and future research endeavours; abiding by all confidentiality measures possible.

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Yes☐ No☐

PLEASE complete IN BLOCK LETTERS

Parent/Guardian(s) name: _____
Parent/Guardian(s) signature: _____
Participant's name: _____
Researcher's name: _____
Researcher's signature: _____
Witness' name: _____
Witness' signature: _____
Date: _____

PARTICIPANT VERBAL ASSENT CONSENT FORM

I, Daniella-Taylyn Moodley, the undersigned researcher have read and fully explained the Parent Information Hand-out and Informed Consent Letter to parent/guardian_____of_____ and any relatives present. The hand-out explains the type, procedure, risks and benefits of the research study that I have invited the parent/guardian and their child to participate in. The parent/guardian indicated that they understood that they have every right to withdraw their child from participating in the study at any time without justification.

In confirmation, the parent/guardian has agreed to participate in this research study.

CHILD VERBAL ASSENT FORM

Child's Name: _____
Participant Number: _____

Hello! My name is Daniella and the Doctor and I would like to see how your voice sounds today.

1. How are you feeling today?

☺ 😐 ☹

2. Would it be OK to look inside your mouth and record your voice today?

Yes☐ No☐

If you don't want to carry on today you may tell us at any time. No one will be angry or upset. Thank you!

AUTHORIZATION FOR RELEASE OF PARTICIPANT INFORMATION

I, _____, hereby authorize the student researcher with the Department of Speech-Language Pathology (University of Pretoria) to release and/or share any information regarding _____, including the diagnosis and records of any evaluation for the dissemination of results for research purposes only. All identifying information will be kept anonymous.

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By signing this authorization, I release the from liability and agree to indemnify and hold the student researcher with the Department of Speech-Language Pathology and Audiology and Dr Carl Swanepoel (Voice Clinic Little Company of Mary) and withholding all legal liabilities in connection with the provision of the aforementioned participant information, liability for any personal injuries (including death) and property losses or damage occasioned by, or in connection with participating in this study.

Signature of Parent/Legal Guardian	Date

Your telephone number:	
Your email address:	
Your spouse's telephone number:	
Your spouse's telephone number:	
Researcher's number:	0721128831
Researcher's email address:	daniellamoodley@gmail.com

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Appendix D Parental Interview/Questionnaire

Appendix E Paediatric Voice Handicap Index (pVHI)

Appendix F Vanderbilt ADHD Diagnostic Parent Rating Scale

Appendix G Voice Assessment Protocol