The Impact of Vocal and Laryngeal Pathologies Among Professional Singers: A Meta-analysis

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Summary: Objective. Professional singers are more likely to develop laryngeal pathologies and symptoms associated with misuse and overuse of the voice. However, different studies have shown conflicting evidence. We aim to perform a systematic review and quantitative meta-analysis to determine the prevalence and risk of laryngeal pathologies and symptoms among professional singers.

Methods. Four electronic databases (MEDLINE, PubMed, EMBASE, and CINAHL) were searched, with no language restrictions. From 3368 potential studies, a total of 21 studies met our inclusion criteria. A systematic review of the literature was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. All cohort, case-control, or cross-sectional studies that reported the risk of laryngeal pathologies in singers were included. Data were pooled by a random effects model and the pooled odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.

Results. There was a positive relationship between singing and laryngeal pathologies. There was an increased risk of hoarseness (OR: 2.00, 95% CI: 1.61–2.49), gastroesophageal reflux disease (GERD) (OR: 1.45, 95% CI: 1.19–1.77), Reinke edema (OR: 2.15, 95% CI: 1.08–4.30), and polyps (OR: 2.10, 95% CI: 1.06–4.14) in professional singers.

Conclusion. Professional singers are at an increased risk of laryngeal pathologies and symptoms associated with vocal misuse and overuse, particularly hoarseness, GERD, edema, and polyps.

Key Words: Singers–Vocal cord symptoms–Reflux–Polyps–Edema.

Level of Evidence: 3b

INTRODUCTION

Singers are a special group of professional voice users who rely almost exclusively on their voices to sustain their livelihoods. Great physical and vocal demands are placed upon them to consistently perform with strong clear voices over long periods of time in occupational environments that may be less than ideal. Hence, they can be considered as "vocal athletes," where any type of injury causing vocal tract symptoms or pathology can have detrimental medicolegal, personal, financial, and vocational aspects and cause significant stress.[1]

Previous studies have identified an association with laryngeal injuries and vocal cord symptoms in professional voice users such as teachers, telemarketers, and radio professionals. However, singers have unique needs and associated lifestyle and environmental characteristics that make them a special group of study. Some of these factors include (1) performance demands; (2) frequent travel; (3) stress and anxiety; (4) venue acoustics and allergens; (5) medication use and abuse; and (6) improper vocal technique.[2]

Performance schedules for professional singers are especially demanding, often requiring shows several nights a week for several weeks to months at a time. Off-stage, singers may engage in recordings or media promotions.[3]

Frequent air and bus travel is common for vocal performers. Noise levels on commercial flights can reach 85–90 dB, and passengers can unknowingly experience the Lombard effect, raising their voices to be heard. Hence, to conduct intelligent conversation, singers may effectively be screaming. Similar effects occur on chartered buses, which may be used for rehearsals during tours.[4]

Stress and anxiety in professional singers is multifactorial and can be exacerbated by the demands of theater management, critical reviews, competition, performance anxiety, auditions, and self-imposed stress. Psychogenic factors can lead to increased vocal strain, muscle tension, and hyperfunction of the vocal cords. Similarly, professional singers can be at a greater risk for gastroesophageal reflux disorder (GERD) through both performance stress, high abdominal pressures during singing, and poor eating habits such as large meals after performances.[5]

Unique environmental factors at the performance venue include allergens from old concert halls, poor acoustics causing the singer to overcompensate, amplification equipment, and use of special theatrical effects including smoke and fog.[3]

Medication and substance use can have specific effects on the vocal cord, contributing toward laryngeal pathologies. Some examples include antihistamines, decongestants, and alcohol, which can dehydrate the vocal cords. Anesthetic lozenges and pain medication, especially if taken for throat pain, can interfere with laryngeal and pharyngeal sensation and further exacerbate any existing injury. Tobacco smoke can both irritate and dehydrate the vocal cord and increase the risk of vocal fold hemorrhage.[6]

Lastly, professional singers are composed of performers with a variety of singing styles ranging from classically trained operatic singers to contemporary artists. The amount, type, and quality of the vocal training are also highly variable. Failure of proper training or lack of singing training results in a significantly

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lower dysphonia severity index scores compared to trained singers. This observation is especially obvious in the realm of commercial music, where the role of training is severely diminished compared to the years of laborious training that classical singers experience.[7]

Management of vocal health in singers is thus an interdisciplinary field, involving otolaryngologists, speech language pathologists, singing teachers, theater managers, and agents. Yet research in singers is a relatively new field, and many clinicians have a poor understanding for the analysis and treatment of voice problems. Furthermore, studies to date in singers have reported conflicting and inconsistent data for laryngeal pathologies and associations. Given this uncertainty and the paucity of systematic evaluations of professional singers to date, we carried out a systematic review and quantitative meta-analysis of published studies of singers that reported prevalence and impact of laryngeal pathologies or vocal cord symptoms.[8]

METHODS

Study protocol

We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.[9] A systematic search of the databases MEDLINE (from 1950), PubMed (from 1946), EMBASE (from 1949), PubMed (from 1950), and Current Contents Connect (from 1980) through February 27, 2018 was carried out to identify relevant articles. The search used the terms "singers" OR "voice professional" OR "performers" AND "larynx" OR "vocal cord" AND "pathology" OR "voice disorder" which were searched as text word and as exploded medical subject headings where possible. The reference lists of relevant articles were also searched for appropriate studies. No language restrictions were used in either the search or study selection. A search for unpublished literature was not performed.

Study selection

We set inclusion criteria for our study and included those studies that (1) have a cohort, case control, or cross-sectional study design; (2) report the risk of laryngeal pathology in professional singers; (3) report the risk point estimate as an odds ratio (OR), or present the data such that the OR could be calculated; and (4) report the 95% confidence interval (CI) or present the data such that the CI could be calculated. We excluded studies that did not meet the inclusion criteria.

Data extraction

One reviewer (MK) performed the data extraction using a standardized data extraction form, collecting information on the publication year, study design, number of cases, number of controls, total sample size, temporal direction, population type, country, continent, economic development, case control matching, mean age, number of adjusted variables, the risk estimates or data used to calculate the risk estimates, CI or data used to calculate CI, and the type of laryngeal pathology observed. Quality of the studies was not assessed and authors were not contacted for missing data. Adjusted ratios were extracted in preference to non-adjusted ratios; however, where ratios were not provided, unadjusted ORs and CIs were calculated. Where more than one adjusted ratio was reported, we chose the ratio with the highest number of adjusted variables. Where multiple risk estimates were available in the same study, for example, because of the use of different comparator groups, they were included as separate risk estimates.

Statistical analysis

Pooled ORs and 95% CIs were calculated for the effect of professional singing on the risk of vocal and laryngeal pathologies using a random effects model.[10] We tested heterogeneity with Cochran Q statistic, with $P < 0.10$ indicating heterogeneity, and quantified the degree of heterogeneity using the I^2 statistic, which represents the percentage of the total variability across studies which is due to heterogeneity. I^2 values of 25%, 50%, and 75% corresponded to low, moderate, and high degrees of heterogeneity, respectively.[11] We quantified publication bias using Egger regression model,[12] with the effect of bias assessed using the fail-safe number method. The fail-safe number was the number of studies that we would need to have missed for our observed result to be nullified to statistical non-significance at the $P < 0.05$ level. Publication bias is generally regarded as a concern if the fail-safe number is less than $5n + 10$, with n being the number of studies included in the meta-analysis.[13] All analyses were performed with *Comprehensive Meta-analysis* version 3.0 (2014) (Biostat, Englewood, NJ).

RESULTS

Study characteristics

From 3368 citations screened by our search, we identified 24 studies that met our inclusion criteria (Table 1). Figure 1 shows the search strategy used to select the studies in this meta-analysis. Subjects included singers whose vocal use demands a majority of their time, including religious singers, opera singers, contemporary singers, singing teachers, choristers, and vocal students. Studies came from various developed and developing countries, with 11 from the USA, 7 from various European countries, 1 from Australia, 3 from Brazil, 1 from Bahrain, and 1 from India. For study design, 12 were cross-sectional, 6 were case-control, and 4 were cohort studies. There was heterogeneity in the method of vocal pathology diagnosis, with 11 studies conducting questionnaires only, 9 studies conducting both questionnaires and ENT evaluations, and 4 studies conducting ENT evaluations only.

Prevalence rates

Table 2 shows the prevalence rates of various vocal cord symptoms and laryngeal pathologies among professional singers. The most prevalent conditions or symptoms affecting professional singers were laryngeal pain 58% (95% CI: 19%–89%), hoarseness 54% (95% CI: 39%–68%), voice fatigue 53% (95% CI: 31%–73%), range impairment 40% (95% CI: 19%–66%), vocal fold hypertrophy 34% (95% CI: 10%–70%), GERD 33% (95% CI: 23%–44%), vocal fold hypermobility 32% (95% CI: 22%–45%), muscle tension dysphonia 28% (95% CI: 17%–43%), vocal cord varices 28% (95% CI: 13%–48%), Reinke edema 21% (95%

TABLE 1.
Characteristics of Studies Included in the Meta-analysis

Source	Study Type	Country	Cases	Total Size	Population	Major Outcomes Measured	Diagnosis Method
Al Bareeq et al[14]	Cohort	Bahrain	130	130	Muslim preachers and singers	Hoarseness, MTD, laryngeal pain, range impairment, GERD, nodules, polyps, VF hemorrhages	Clinical examination including mirror indirect laryngoscopy, upper endoscopy, and pernasal endoscopy
Arunachalam et al[15]	Cross sectional	India	45	45	Carnatic singers	MTD, VF hypermobility, Reinke edema, nodules, polyps	Clinical history, strobovideolarynoscopic examination, perceptual assessment, aerodynamic measures, acoustic analysis, patient self-evaluation
Cammarota et al[16]	Cohort	Italy	351	929	Professional opera singers	Hoarseness, GERD	Questionnaire
Da Silva et al[17]	Field intervention	Brazil	26	26	Dysphonia patients	MTD, laryngeal pain, Reinke edema	Questionnaire (Vocal Screening Protocol)
Fortes et al[18]	Cohort	Brazil	25	25	Singers	GERD, varices, Reinke edema, nodules, polyps	Retrospective chart review, including strobovideolaryngoscopic results
Hapner and Gilman[19]	Cohort	USA	58	58	Jewish cantors	MTD, laryngeal pain, range impairment, chronic irritation/ cough, Reinke edema, volume impairment, voice fatigue, voice strain	Questionnaire
Heman-Ackah et al[20]	Case control	USA	7	7	Singing teachers	GERD, Varix, VF hypermobility, Reinke edema, polyps, cyst, VF scarring	Questionnaire and strobovideolaryngoscopic examination
Hočevar-Boltežar[21]	Cross sectional	Serbia	340	340	Catholic priests	GERD, chronic irritation/cough	Questionnaire
Hočevar-Boltežar et al[22]	Case control	Serbia	117	228	Professional choristers	GERD	Questionnaire with Reflux Symptom Index
Koufman et al[23]	Cross sectional	USA	67	67	Professional voice users	MTD, voice fatigue	Clinical history and strobovideolaryngoscopic examination
Lierde et al[24]	Case control	Brazil	320	1152	Professional voice users	Laryngeal pain	Questionnaire
Lundy et al[25]	Cross sectional	USA	65	65	Vocal students	Hoarseness, range impairment, chronic cough/irritation, Reinke edema, nodule, cyst, volume impairment, VF erythema	Questionnaire and laryngoscopic examination
Miller and Verdolini[26]	Case control	USA	125	174	Voice teachers	Hoarseness, range impairment, chronic cough/irritation, voice fatigue	Questionnaire

(*Continued*)

TABLE 1.
(*Continued*)

Source	Study Type	Country	Cases	Total Size	Population	Major Outcomes Measured	Diagnosis Method
Mishra et al[27]	Cross sectional	USA	40	40	Singers with "acute voice problems"	Varix, Reinke edema, nodule, VF hemorrhage	Clinical and strobovideolaryngoscip examination
Mozzanica et al[28]	Cross sectional	Italy	310	310	Professional voice users	MTD, VF hypertrophy, VF paralysis	Videolaryngoscopy, perceptual voice assessment (GIRBAS scale), VHI questionnaire
Rosen and Murry et al[29]	Case control	USA	119	488	Singers	MTD, GERD, Reinke edema, nodule, polyp, cyst, VF scarring, VF hemorrhage	VHI questionnaire clinical examination, strobovideolaryngospy, acoustic analysis and aerodynamic measures
Myint et al[30]	Cross sectional	USA	51	51	Voice students	MTD, reflux, VF varices, VF nodules, VF polyps, VF hemorrhages	Retrospective chart review, strobovideolaryngscopy, clinical examination
Phyland et al[1]	Case control	Australia	171	257	Professional singers	Chronic cough/irritation, Reinke edema, nodule, polyp	Questionnaire
Sapir et al[31]	Cross sectional	USA	74	74	Voice students	Hoarseness, MTD, laryngeal pain, range impairment, voice fatigue	Questionnaire
Sataloff et al[32]	Cross sectional	USA	129	129	Child and adolescent choristers	Hoarseness, MTD, range impairment, volume impairment, voice fatigue	Questionnaire
Sataloff 1b et al[33]	Cross sectional	USA	72	72	Voice teachers and trained singers	GERD, Varix, Reinke edema, VF hemorrhage, VF hypertrophy	Questionnaire, strobovideolaryngoscopy, and acoustic analysis
Schmid et al[34]	Cross sectional	Austria	28	28	Amateur choristers	Hoarsness, MTD, range impairment, chronic cough/ irritation, Reinke edema, polyp, VF hypertrophy	Multidisiplinary clinical examination
Pregun et al[35]	Cross sectional	Hungary	202	317	Professional choristers	Hoarseness, GERD	Questionnaire
Bonet et al[36]	Cross sectional	Spain	99	0	Child choristers	Range impairment	Physical examination (Wendler Classification) + vocal exercise + videolaryngoscopy

VF, vocal fold; VHI, Voice Handicap Index.

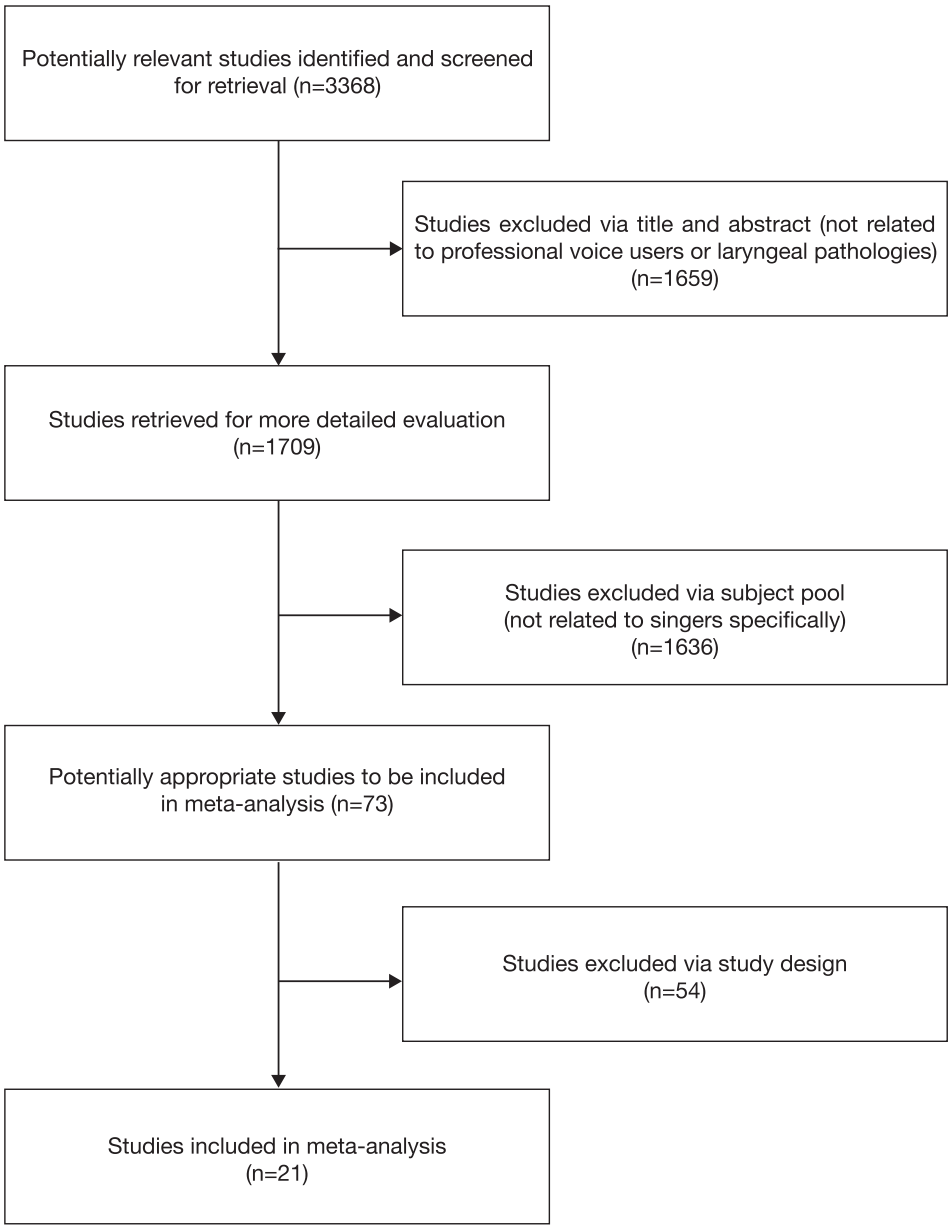

FIGURE 1. Flowchart of the systematic study selection.

CI: 11%–38%), volume impairment 18% (95% CI: 13%–24%), chronic irritation and cough 16% (95% CI: 8%–31%), vocal cord nodules 15% (95% CI: 7%–31%), vocal cord cysts 13% (95% CI: 2%–54%), vocal cord polyps 13% (95% CI: 4%–33%), vocal fold scarring 6% (95% CI: 3%–11%), vocal fold hemorrhages 4% (95% CI: 1%–16%), and vocal cord paralysis 6% (95% CI: 4%–9%).

Hoarseness

Eight studies comprising 1259 individuals were initially identified for the hoarseness meta-analysis. However, only three studies had both cases and controls. Singers were twice as likely to experience hoarseness compared to non-singers (OR: 2.00, 95% CI: 1.61–2.49) (Figure 2). There was no heterogeneity ($I^2 = 0.00$, $P = 0.50$) among these studies.

GERD

There were 11 studies comprising 2596 individuals who were initially identified for the GERD analysis. However, there were only seven case-control studies that showed an increased risk of GERD (OR: 1.45, 95% CI: 1.19–1.77) among singers (Figure 3). There was a low level of non-significant heterogeneity which was not statistically significant ($I^2 = 10.23$, $P = 0.35$).

TABLE 2.
Prevalence Estimates for the Various Pathologies Reported From the Studies

Outcome	Cases	Total Size	Prevalence (%)	Heterogeneity
Chronic irritation/cough	392	397	16% (95% CI: 8–31)	$I^2 = 86.00$, $P < 0.001$
Cysts	17	46	13% (95% CI 2–54%)	$I^2 = 92.11$, $P < 0.001$
GERD	460	726	28% (95% CI 19–38%)	$I^2 = 91.68$, $P < 0.001$
Hoarseness	586	753	54% (95% CI 39–68%)	$I^2 = 93.65$, $P < 0.001$
Laryngeal pain	891	1032	69% (95% CI 23–94%)	$I^2 = 98.17$, $P < 0.001$
Muscle tension dysphonia	230	277	27% (95% CI 12–50%)	$I^2 = 94.97$, $P < 0.001$
Nodules	71	77	11% (95% CI 6–19%)	$I^2 = 79.98$, $P < 0.001$
Polyps	47	69	9% (95% CI 4–18%)	$I^2 = 80.21$, $P < 0.001$
Range impairment	362	367	37% (95% CI 19–59%)	$I^2 = 95.27$, $P < 0.001$
Reinke edema	144	165	19% (95% CI 9–37%)	$I^2 = 92.86$, $P < 0.001$
Varix	27	37	27% (95% CI 9–56%)	$I^2 = 87.77$, $P < 0.001$
VF hemorrhages	31	38	4% (95% CI 1–20%)	$I^2 = 87.49$, $P < 0.001$
VF hypermobility	18	21	32% (95% CI 22–45%)	$I^2 = 0.00$, $P = 0.38$
VF hypertrophy	54	54	47% (95% CI 17–79%)	$I^2 = 89.36$, $P = 0.002$
VF scar	7	17	6% (95% CI 3–11%)	$I^2 = 0.00$, $P = 0.88$
Voice fatigue	368	379	53% (95% CI 31–73%)	$I^2 = 94.12$, $P < 0.001$
Volume impairment	125	125	18% (95% CI 13–24%)	$I^2 = 0.00$, $P = 0.37$

VF, vocal fold; GERD, gastroesophageal reflux disorder.

Reinke edema

There were 10 studies comprising 2596 participants who were initially identified for the Reinke edema analysis. However, there were only four case-control studies that showed an increased risk of edema (OR: 2.15, 95% CI: 1.08–4.30) among singers (Figure 4). There was no heterogeneity ($I^2 = 0.00$, $P = 0.92$) among these studies.

Polyps

There were 12 studies comprising 2260 participants who were initially identified for the polyps analysis. However, there were only six case-control studies that showed an increased risk of polyps (OR: 2.10, 95% CI: 1.06–4.14) among singers (Figure 5). There was no heterogeneity among these studies ($I^2 = 0.00$, $P = 0.45$).

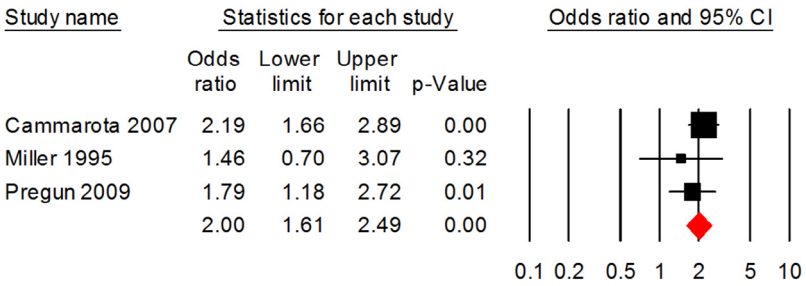

FIGURE 2. Forest plot showing the relationship between hoarseness and singing.

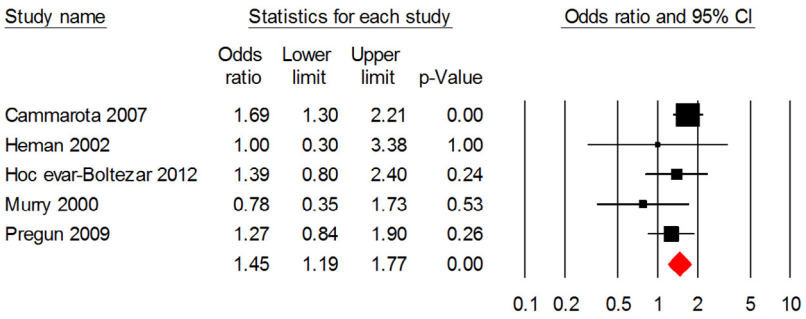

FIGURE 3. Forest plot showing the relationship between GERD and singing.

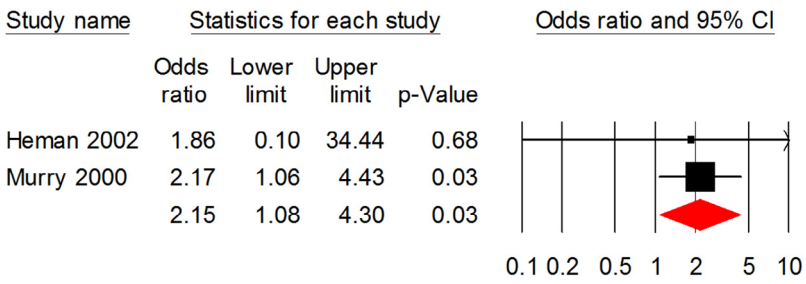

FIGURE 4. Forest plot showing the relationship between edema and singing.

Publication bias

An Egger regression analysis showed there was no evidence of publication bias ($P = 0.27$).

DISCUSSION

Our systematic review and meta-analysis shows that singers are at an increased risk of laryngeal pathologies and symptoms associated with overuse and misuse, namely, hoarseness, GERD, Reinke edema, and polyps.

Heterogeneity of the study pool may also have contributed toward heterogeneity of data. Participants ranged from singing teachers[20,26] to religious priests[14,19,21] to opera singers.[16]

Variables include performance demands and environments, peak seasons, and breakdown of time schedule.[19,37] Differences in singing style can also account for differences in risk for laryngeal pathology and vocal cord symptoms. Classical singers may be more likely to use warm-up routines compared to popular singers. Postures in singing also vary; classical singers are more likely to assume a neutral stance, whereas musical theater singers may be required to vary their postures according to their role or dance simultaneously. Technical demands to produce specific qualities of sound vary between types of singers. Country and Western singers may desire a hypernasal sound produced by a high laryngeal position, whereas pop singers may desire more vocal harshness, and musical theater singers may frequently use belting, where arytenoid and thyroarytenoid muscles may be contracted to a high degree.[38] Although physiological demands between musical styles differ, existing studies attempting to compare severity and frequency of vocal cord symptoms between styles have reported conflicting evidence.[37,39]

Variation in the age groups of participants may also have contributed toward heterogeneity of self-reported laryngeal pathologies. Sataloff et al[32] examined child and adolescent singers, where the anatomy and physiology of the larynx is changing. During puberty the vocal folds increase 1.0–3.5 mm in girls and 4–6 mm in boys. The thyroid cartilage angle in pubertal boys changes from roughly 120° to 90° and the fundamental frequency drops to roughly 130 Hz, causing pitch fluctuations known as mutational falsetto.[40]

One of our study's limitation was the small sample size of the studies involved, likely due to the highly specific population of voice professionals and specialized nature of data collection with videolaryngoscopy and ENT evaluation. Many of the reviewed articles revolved around a single location such as a conservatory or a static timeframe such as a conference instead of a coordinated multicentre or prospective effort.

However, our study had a number of strengths. We followed the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) guidelines to perform our systematic review and used a broad search using multiple databases that were not limited to the English language. We included studies that reported data where the OR could be calculated.

CONCLUSION

Our systematic review and meta-analysis shows that singers are at an increased risk of laryngeal pathologies and vocal cord symptoms. Results are limited because of the small number of studies available for analysis, small control subject pool, and heterogeneity in diagnostic evaluation.

Further studies with standardized and objective analysis are needed, namely, by using a Voice Handicap Index questionnaire followed by a comprehensive ENT and speech language pathologist evaluation and strobolaryngoscopy. Proposed future directions include designing a larger-scale retrospective cohort study measuring information about the exposure variables (amount and type of warm-up, length of singing, type of singing) with the presence, severity, and types of vocal pathologies using standardized indices. Focus groups can be conducted to understand more deeply genre-specific and performance-related factors in certain types of regular singers. This application of knowledge

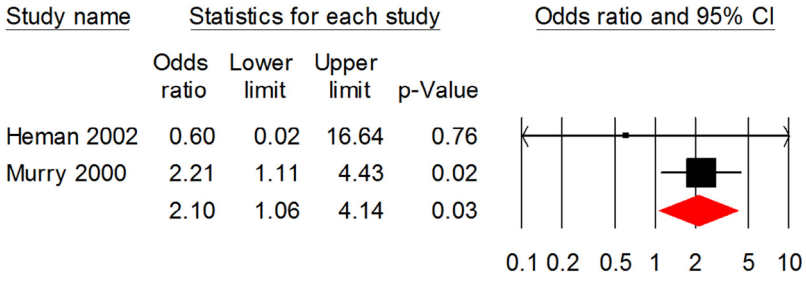

FIGURE 5. Forest plot showing the relationship between polyps and singing.

can assist in developing more tailored educational tools to enable more consistent vocal performance in voice professionals.

REFERENCES

1. Phyland DJ, Thibeault SL, Benninger MS, et al. Perspectives on the impact on vocal function of heavy vocal load among working professional music theater performers. *J Voice*. 2013;27:390, e31-9.
2. Davies DG, Jahn AF. *Care of the Professional Voice: A Guide to Voice Management for Singers, Actors, and Professional Voice Users*. 2 ed. London: Butterworth Heinemann; 2004.
3. Davies DG, Jahn AF. Popular music and the music theatre. In: *Care of the Professional Voice: A Guide to Voice Management for Singers, Actors, and Professional Voice Users*. 2 ed. London: Butterworth Heinemann; 2004:61–71.
4. Davies DG, Jahn AF. Anxiety, artistic temperament, and the voice. In: *Care of the Professional Voice*. London, United Kingdom: Butterworth Heinemann; 2004:51–60.
5. Davies DG, Jahn AF. Travel and the vocal performer. In: *Care of the Professional Voice*. London, United Kingdom: Butterworth Heinemann; 2004:73–77.
6. Davies DG, Jahn AF. Medications and the professional voice. In: *Care of the Professional Voice*. London, United Kingdom: Butterworth Heinemann; 2004:78–87.
7. Radionoff S. Artistic vocal styles and technique. In: Benninger MS, Murry T, eds. *The Performer's Voice*. Abingdon, Oxfordshire, United Kingdom: Plural Publishing; 2006:51–59.
8. Benninger MS, Murry T. *The Performer's Voice*. Abingdon, Oxfordshire, United Kingdom: Plural Publishing; 2006.
9. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264–269.
10. Dersimonian R, Larid N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7:177–188.
11. Higgins J, Thompson S, Deeks J. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327:557–560.
12. Egger M, Davey S, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical test. *Br Med J*. 1997;315:629–634.
13. Orwin R. A fail-safe N for effect size in meta-analysis. *J Educ Stat*. 1983;8:157–159.
14. Al Bareeq JM. Voice overuse and abuse among professional voice. *Bahrain Med Bull*. 2001;23:12–18.
15. Arunachalam R, et al. Clinical voice analysis of carnatic singers. *J Voice*. 2013;28:128.e121–128.e129.
16. Cammarota G, Masala G, Cianci R, et al. Reflux symptoms in professional opera choristers. *Gastroenterology*. 2007;132:890–898.
17. Da Silva WJN, Lopes LW, de Macedo AER, et al. Reduction of risk factors in patients with behavioural dysphonia after vocal group therapy. *J Voice*. 2017;31:123.e15–123.e19.
18. Fortes F, et al. Profile of voice professionals seen in a tertiary health centre. *Braz J Otorhinolaryngol*. 2007;73:27–31.
19. Hapner E, Gilman M. The vocal load of reform Jewish Cantors in the USA. *J Voice*. 2012;26:201–204.
20. Heman-Ackah YD, Dean CM, Sataloff RT. Strobovideolaryngoscopic findings in singing. *J Voice*. 2002;16:81–86.
21. Hočevar-Boltežar I. Prevalence and risk factors for voice problems in priests. *Wien Klin Wochenschr*. 2009;121:276–281.
22. Hočevar-Boltežar I, Šereg-Bahar M, Kravos A, et al. Is an occupation with vocal load a risk factor for laryngopharyngeal reflux: a prospective, multicentre, multivariate comparative study. *Clin Otolaryngol*. 2012;37:362–368.
23. Koufman J, et al. Vocal fold paresis. *Otolaryngol Head Neck Surg*. 2000;122:537–541.
24. Lierde K, et al. Type and severity of pain during phonation in professional voice users and nonvocal professionals. *J Voice*. 2012;26:671.e619–671.e623.
25. Lundy D, et al. Incidence of abnormal laryngeal findings in asymptomatic singing students. *Otolaryngol Head Neck Surg*. 1999;121:69–77.
26. Miller MK, Verdolini K. Frequency and risk factors for voice problems in teachers of singing and control subjects. *J Voice*. 1995;9:348–362.
27. Mishra S, et al. 24 hours prior to curtain. *J Voice*. 2000;14:92–98.
28. Mozzanica F, Ginocchio D, Barillari R, et al. Prevalence and voice characteristics of laryneal pathology in an Italian voice therapy-seeking population. *J Voice*. 2016;30:774, e13-21.
29. Rosen CA, Murry T. Voice Handicap Index in singers. *J Voice*. 2000;14:330–377.
30. Myint C, Moore JE, Hu A, et al. A comparison of initial and subsequent follow-up strobovideolaryngoscopic examinations in singers. *J Voice*. 2016;30:472–477.
31. Sapir S. Vocal attrition in voice students: survey findings. *J Voice*. 1993;7:69–74.
32. Sataloff RT, Reilly JS, Lawless S. A pilot survey of vocal health in young singers. *J Voice*. 2002;16:244–250.
33. Sataloff RT, et al. Prevalence of abnormal laryngeal findings in healthy singing teachers. *J Voice*. 2012;26:577–583.
34. Schmid-Tatzreiter, E, Schmid R. Interdisciplinary voice examination (screening) for (choir) singers at the 'Salzburger Sanger Service-Tag 2003'. *Logop Phoniatr Vocol*. 2004;29:92–96.
35. Pregun I, et al. Gastroesophageal reflux disease: work-related disease? *Digest Dis*. 2009;27:38–44.
36. Bonet, M, Casan P. Evaluation of dysphoia in a children's choir. *Folia Phoniatr Logop*. 1994;46:27–34.
37. Phyland DJ, Oates J, Greenwood KM. Self-reported voice problems among three groups of professional singers. *J Voice*. 1999;13:602–611.
38. Davies DG, Jahn AF. Popular music and the musical theatre. In: *Care of the Professional Voice*. London, United Kingdom: Butterworth Heinemann; 2004.
39. Burns P. Acoustical analysis of the underlying voice differences between two groups of professional singers: opera and country and western. *Laryngoscope*. 1986;96:549–554.
40. Davies DG, Jahn AF. Development of the larynx and the voice. In: *Care of the Professional Voice*. London, United Kingdom: Butterworth Heinemann; 2004.