

## REFLUX DISEASE IN SINGERS: A SYSTEMATIC REVIEW

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### KEYWORDS

Laryngeal—Otolaryngology—Otorhinolaryngology—Voice—Laryngopharyngeal—Reflux—Singing—  
Singer—Professional—Dysphonia—Hoarseness.

### ABSTRACT

**Objective.** To investigate the laryngopharyngeal reflux disease (LPRD) features in singers. **Methods.** According to the PRISMA statements, two investigators searched the literature related to the prevalence of symptoms, findings, and clinical therapeutic outcomes of reflux in singers through a PubMed, Scopus, and Cochrane Library systematic review.

**Results.** Of the 91 identified studies, 18 publications met the inclusion criteria, accounting for 2288 singers and 1398 controls, respectively. There were 1243 (54.3%) professional singers, 450 (19.7%) amateurs, 329 (14.4%) singing students, and 102 (4.5%) singing teachers. The LPRD diagnosis and findings were based on objective evaluations in 2/18 studies. According to validated and unvalidated patient-reported outcome questionnaires, reflux symptoms have been found in 25.0% to 65% of singers, with a RSI > 13 in 25.0%-33.9% of cases. The prevalence of LPRD signs ranged from 18.1% to 73.4% of singers without voice complaints and 18.1%-73.4% of singers with voice complaints at the time of the evaluation. No study investigated the pretreatment to post treatment changes in symptoms, findings, and voice outcome. Substantial heterogeneity was found between studies for reflux diagnosis, symptom and sign evaluations, singer profiles (musical styles, voice range), and association outcomes.

**Conclusion.** The prevalence of symptoms and findings attributed to LPRD can be high in singer populations. However, the nonspecificity of symptoms and findings, the lack of objective reflux testing, and the heterogeneity in the singer profile limit the drawing of valid conclusions for the prevalence of LPRD. Based

on the findings collected in this systematic review, the authors proposed a semistructured questionnaire, including key points for primary singer evaluation.

## INTRODUCTION

Laryngopharyngeal reflux disease (LPRD) is a disease of the upper aerodigestive tract resulting from the direct and/ or indirect effects of gastroduodenal content reflux, inducing morphological and/or neurological changes in the upper aerodigestive tract.<sup>1</sup> The prevalence of LPRD is commonly high in laryngology, reaching 50% of patients consulting in voice clinics.<sup>2</sup> The deposit of gastroduodenal content into the vocal folds can lead to several macroscopic and microscopic mucosa changes over time and related modifications of the tissue biomechanical properties affecting the voice quality.<sup>3,4</sup> Professional voice users, eg, teachers, singers, or actors, have been long time suggested to have a higher risk of developing LPRD and related dysphonia compared with the general population,<sup>5</sup> which can be attributed to their different vocal strains, diet habits (late-night eating), stress, and anxiety patterns.<sup>5,6</sup> Despite the constant evolution of LPRD knowledge, the data about the LPRD prevalence, consequences, and impact on voice quality in singers are still limited.

The present systematic review aimed to summarize the literature findings for the prevalence of LPRD symptoms, findings, and clinical therapeutic outcomes in singers and propose some future ways to improve the reflux care of voice professionals.

## MATERIALS AND METHODS

The criteria related to the inclusion and exclusion of studies were based on the population, intervention, comparison,

outcome, timing, and setting framework.<sup>7</sup> Two independent investigators [a laryngologist (JRL) and a university librarian (GB)] conducted the systematic review and data collection according to the PRISMA checklist for systematic reviews.<sup>8</sup> The study was not registered in PROSPERO database.

### PATIENT POPULATION

Cross-sectional population, prospective or retrospective, controlled, uncontrolled, or randomized clinical studies published between January 1994 and October 2024 (30- year period) were considered. The studies

were published in English, Spanish, or French peer-reviewed journals. The studies had to report data for at least ten subjects. Case reports were not considered. The authors carefully reported the inclusion criteria of the studied population, which consisted of amateur or professional singers, singing teachers, or singing students. Similar data availability was considered for control groups. To be included, the authors had to investigate the prevalence of symptoms/findings suggestive of LPRD, and therapeutic outcomes in singers. There were no exclusion criteria based on age, ethnicity, socioeconomic status, comorbidities, singing styles, voice range/classification, or singing experience. Based on the Dubai criteria,<sup>1</sup> the LPRD diagnosis was considered as confirmed if subjects showed more than one pharyngeal reflux event at the 24-hour hypopharyngeal-esophageal multichannel intraluminal pH-impedance study (HEMII- pH). A LPRD diagnosis based on symptoms, findings, gastrointestinal endoscopy (GI) features, single-, dual-, or triple-probe pH monitoring, oropharyngeal pH monitoring, and MII-pH without pharyngeal sensors was not considered as confirmed, and, consequently, the LPRD was considered as suspected.<sup>1</sup> Consistent with past and current guidelines, gastroesophageal reflux disease (GERD) diagnosis was based on DeMeester score, Montreal, or Lyon guidelines.<sup>9</sup>

## **INTERVENTION AND COMPARISON**

Studies assessing the LPRD prevalence or voice quality outcomes in singing populations were considered, irrespective of comparison with an asymptomatic group.

## **OUTCOMES**

The following outcomes were collected by the two investigators: study design, number of subjects, gender ratio, mean/median age, profiles and types of singers, voice range/ classification, LPRD diagnosis criteria, voice quality outcomes, and outcome association/results. Potential confounding outcomes of clinical LPRD diagnosis or voice assessments also were collected for the bias analysis, eg, antireflux medication intake, allergy, occupational factors, tobacco, alcohol overuse, and other respiratory comorbidities.

## **TIMING AND SETTING**

There were no criteria for specific stages or timing in the “disease process” of the study population. Primary or recalcitrant LPRD was considered. Singers with or without voice complaints were considered.

## SEARCH STRATEGY

The two investigators conducted the literature search on PubMed, Scopus, and Cochrane databases. The databases were screened for titles and abstracts referring to the description of LPRD findings in singers. The full texts of the selected publications were reviewed for relevance, and the reference lists of the selected publications were examined for additional pertinent studies. Any discrepancies in the synthesized data were discussed by the laryngologist and the librarian. The following keywords were associated with AND/ OR in databases: “laryngeal”; “reflux”; “gastroesophageal”; “laryngopharyngeal”; “voice”; “singing”; “singer”; “prevalence”; “incidence.” The type of study was classified according to the levels of evidence (I-V).<sup>10</sup>

## BIAS ANALYSIS

The validated methodological index for non-randomized studies (MINORS) tool was used for the bias analysis and the assessment of the quality of non-randomized surgical studies.<sup>11</sup> The MINORS tool consists of 12 items related to the analysis of methodological points of comparative and non-comparative studies. The items were scored 0 if absent, 1 when partially reported or inadequate, and 2 when reported and adequate. The aim of the study was rated as stated clearly (2), unclear (1), or absent (0). The inclusion of patients was judged for clearly reported consecutive inclusion (2), unclear consecutive inclusion (1), or no consecutive inclusion (0). The data collection was rated as prospective (2), retrospective analysis of prospective recruited patients (1), or not specified (0). The quality of endpoints was considered as high (2) if the authors assessed the outcomes with validated patient-reported outcome questionnaires (PROMs), validated clinical instruments, or objective outcomes. The blinded evaluation of videolaryngostroboscopic findings regarding the patient symptoms/ group has been considered adequate (2), while the evaluation of laryngeal findings in the consultation was considered at risk of bias (1). The use of an unvalidated PROM or instrument for the assessment of symptoms and findings was considered low (0). In the prospective studies evaluating the reflux or voice outcomes change over time, the follow-up period was considered adequate (2) for at least 3 months of treatment. A shorter follow-up was considered less valid. Finally, the 5% rate of lost-to-follow-up patients or nonresponders to a survey was considered as the threshold by the MINORS. The requirement for a study size sample calculation was considered adequate (2). The ideal MINORS score was 16 for noncomparative studies and 24 for comparative studies.<sup>11</sup> Moreover, additional

outcomes have been considered and discussed in the bias analysis, including the heterogeneity across studies in reflux diagnosis criteria, populations, and outcomes.

## RESULTS

Of the 91 identified studies, 18 publications<sup>12–29</sup> met the inclusion criteria (Figure 1). There were ten cross-sectional studies,<sup>12–15,18,22,24–27</sup> three controlled prospective studies,<sup>16,20,23</sup> two uncontrolled prospective studies,<sup>17,21</sup> and three retrospective chart reviews,<sup>19,28,29</sup> accounting for 2288 singers and 1398 controls (Table 1). Overlap was detected in two studies from the same research team,<sup>6,22</sup> and the study with substantially fewer data was excluded.<sup>6</sup> The demographics, clinical, and singing features of populations are described in Table 2. Of the 2288 singers, 1243 (54.3%) were professionals, 450 (19.7%) were amateurs, 329 (14.4%) were students, and 102 (4.5%) were described primarily as teachers. The data were unclear or not specified for 165 individuals. Gender information was reported in most studies (Table 2). There were 1276 (55.8%) females and 797 (34.8%) males, respectively. The mean age of singers ranged from 23.0 to 51.8 years. Classical (90.9%), pop (3.8%), sacred (1.7%), and theater (1.7%) music were the most frequent musical styles. Among classical opera singers, 1068 (85.0%) subjects were choristers, and 188 (15.0%) were soloists. The most frequent voice classifications were soprano (54.6%) in females and tenor (49.9%) in males, respectively (Table 2). The studies investigated reflux features in singers without primary voice complaints ( $n = 4$ ),<sup>12,16,17,21</sup> singers with voice complaints ( $n = 3$ ),<sup>19,26,28</sup> and both singer populations ( $n = 11$ ),<sup>13–15,18,20,22–25,27,29</sup> respectively.

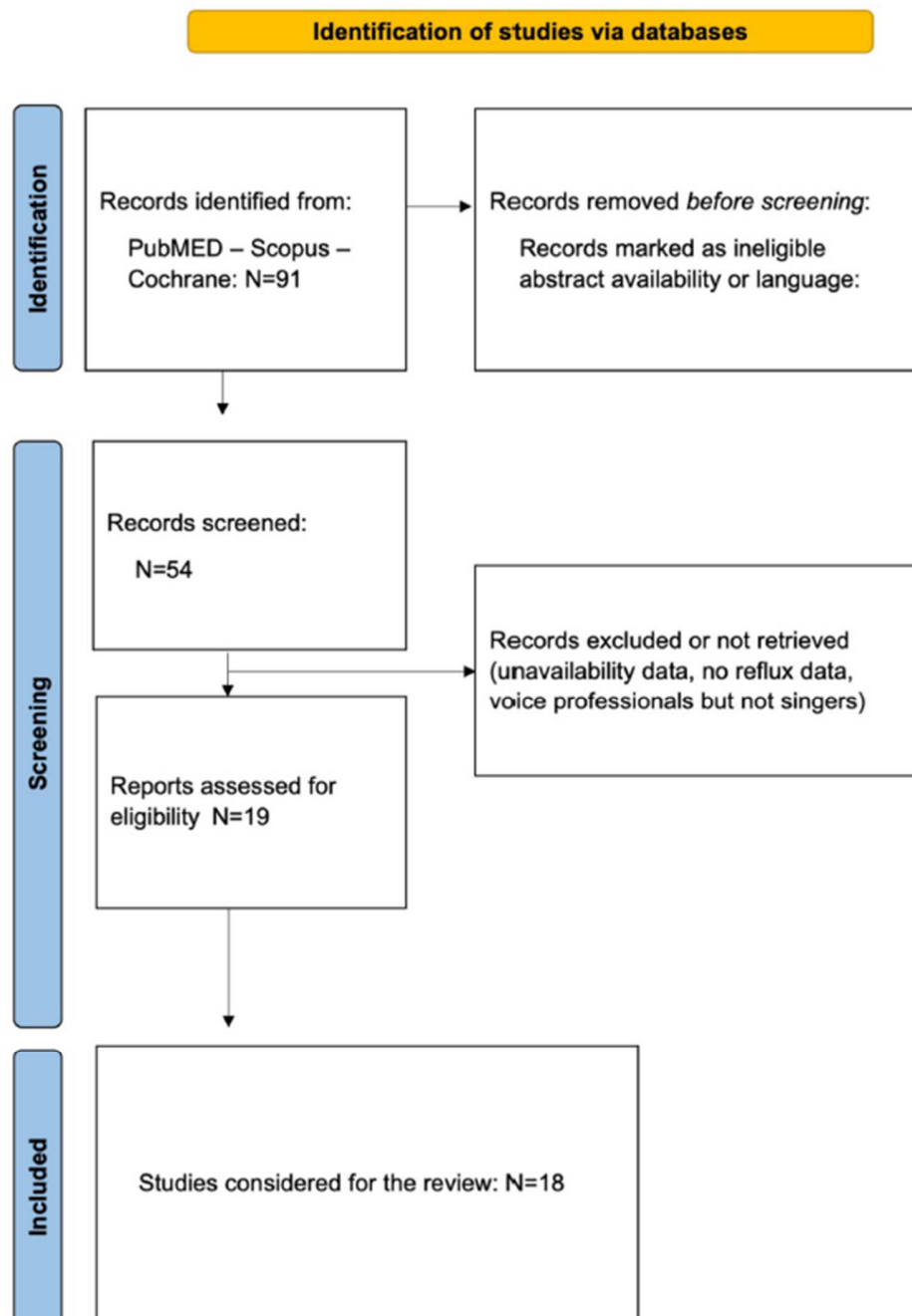


FIGURE 1. PRISMA flowchart.

**TABLE 1.**  
**Demographics, Singing, and Clinical Outcomes of Studies**

References	Design	N and Populations	HS	Csi	FIM (O)	Age (y)	Reflux diagnosis	Voice outcomes	Results
Lundy et al <sup>12</sup>	Cross-sectional	65 singing students	+	-	42/15 8 NP	23.5	VLS	Posterior laryngeal erythema Reflux medication LPRD symptom/sign (VLS)	73.4% 15 (26.3%) 13 (65%)-20 (100%) Choristers > HC Choristers > HC
Heman et al <sup>14</sup>	Cross-sectional	20 singing teachers	+	+	17/3	50	VLS-unvalidated PROM	Heartburn, hoarseness	Choristers > HC
Pregun et al <sup>15</sup>	Cross-sectional	202 pro choristers 115 HC	+	+	NP	NP	Unvalidated PROM	Regurgitations	Choristers > HC
Hocevar et al <sup>16</sup>	Mult. Prosp. Cont.	119 pro choristers 111 HC	+	-	61/58 68/43	42.5 39.3	RSI > 13	RSI score RSI > 13 (CH/HC)	Choristers > HC 20 (17%)/11 (10%)
Sataloff et al <sup>17</sup>	Uncontr. Prosp.	72 singing teachers	+	-	60/12	48.7	RFS > 7	RFS > 7	13 (18.1%)
Robbott et al <sup>18</sup>	CS online Survey	392 ama singers 514 HC	+	+	263/129 277/179	39.5 41.8	RSI > 13	RSI score/reflux medication Heartburn/reflux (GI)	Choristers = HC HC > choristers
Myint et al <sup>19</sup>	Retrospective	51 singing students	-	+	23/28	26.0	RFS > 7	RFS > 7 (initial evaluation) RFS > 7 (follow-up)	20/29 (69.0%) 65/72 (90.3%)
Naoci et al <sup>20</sup>	Prospective Controlled	56 singing students 60 HC	+	+	32/24 34/26	26.5 27.9	RSI > 13 and RFS > 7	RSI and RFS	Singers > HC 14 (25%)-5 (8.4%)
Lloyd et al <sup>21</sup>	Prospective Uncontrolled	20 pro singers	+	-	13/7	38.7	RSI and Oropharyngeal pH testing	RSI > 13 (singers-HC) RFS > 7 (singers-HC) pH: 6-6.5 up/5.5-6 su pH: 5.5-6 up/5 -5.5 su	7 (12.5%)-1 (1.7%) 19 15
Lenti et al <sup>22</sup>	Cross-sectional	116 pro soloists 351 pro choristers 578 HC	+	+	54/62 194/157 332/246	34.1 40.8 36.2	GERD montreal Symptoms	GERD-heartburn/dysphonia GERD-regurgitation GERD-dysphagia Positive peptest	So > HC; So=Ch So > HC; So=Ch So > HC; So > Ch 29 (97%)-6 (30%)
Loor <sup>23</sup>	Prospective Controlled	30 singing students 20 HC	+	+	18/12 13/7	23.0 27.0	Saliva pepsin		
Santos et al <sup>24</sup>	CS survey	57 pro singers	+	+	31/26	32.0	GERD symptoms	GERD prevalence	Drinkers > non-drinkers
Naoci et al <sup>25</sup>	Cross-sectional	42 singing students	+	+	26/16	24.9	RSI > 13	RSI > 13-SVHI > 20.35 RSI and SVHI correlation Signs of LPRD (VLS)	13 (31%)-30 (71.4%) Non-significant 7 (70%)
Korn et al <sup>26</sup>	Cross-sectional	10 HPD teacher singers	-	+	6/4	34	VLS		
Zuim et al <sup>27</sup>	CS online survey	238 pro singers	+	+	153/ 84/1	37.4	GERD history/symptoms	VCP and reflux history	Positive association
Mavraj <sup>13</sup>	CS online survey	144 prof/ama singers	+	+	93/47/4	51.8	Unvalidated PROM	Reflux medication	43 (29.9%)
Campagnolo <sup>28</sup>	Retrospective	140 pro singers/ actors	-	+	87/53	32.0	VLS and RFS	RFS > 6—reflux dysphonia	47 (33%)-19/47 (40%)
Naoci et al <sup>29</sup>	Retrospective of prospective data	163 prof/ama singers or students	+	+	103/60	33.3	RSI > 13	RSI > 13	54 (33.9%)

Abbreviations: Ama, amateur; Ch, choristers; CS, cross-sectional; SC, singers with complaints; GERD, gastroesophageal reflux disease; GI, gastrointestinal endoscopy; HC, healthy controls; HS, healthy singers; Mult. Prosp, Cont., multicenter prospective controlled; N, number; NP, not provided; Pro, professional; PROM, patient-reported outcome questionnaire; RFS, reflux finding score; RSI, reflux symptom index; So, soloists; su, supine; up, upright; VCP, vocal cord pathology; VLS, videolaryngostroboscopy; y, years.

**TABLE 2.**  
**Summary of Population Features Included in the Review**

Outcomes	N	%
<i>Gender (singers)</i>		
Females	1276	55.8
Males	797	34.8
No binary/others	4	0.2
Not provided	211	9.2
<i>Range of mean age</i>	23.0-51.8 years	
<i>Subjects (total)</i>	2288	
Professional singers	1243	54.3
Amateur singers	450	19.7
Student singers	329	14.4
Singing teachers	102	4.5
Not provided	164	7.2
<i>Healthy individuals</i>	1398	
<i>Musical/singing styles</i>		
Classical	1577	90.9
Pop	66	3.8
Sacred	30	1.7
Theater	29	1.7
Rock	8	0.5
Show	7	0.4
Jazz	6	0.3
Gospel	4	0.2
Spiritual	3	0.2
Nightclub	2	0.1
Country	2	0.1
Blues	1	0.1
<i>Singer types (classical/opera)</i>		
Choristers	1068	85.0
Soloists	188	15.0
<i>Voice range/classification</i>		
<i>Females</i>		
Soprano	370	54.6
Mezzo-soprano	174	25.7
Alto	134	19.8
<i>Males</i>		
Tenor	218	49.9
Baritone	133	30.4
Bass	86	19.7

Abbreviations: N, number.

## REFLUX DIAGNOSIS OUTCOMES

In nine studies, the reflux diagnosis was based on GERD or LPRD symptoms without considering laryngeal examinations.<sup>13,15,16,18,22,24,25,27,29</sup> Among them, the symptoms were evaluated with the reflux symptom index (RSI)<sup>30</sup> in six studies,<sup>16,18,20,21,25,29</sup> considering the validated threshold (RSI > 13) in five publications.<sup>16,18,20,25,29</sup> GERD symptoms were used primarily for the LPRD diagnosis in three studies.<sup>22,24,27</sup> The authors based the LPRD diagnosis on laryngeal signs in six studies.<sup>12,14,17,19,26,28</sup> The authors did not use clinical sign instruments in three studies.<sup>12,14,26</sup> The validated reflux finding score (RFS)<sup>31</sup> was used in four studies.<sup>17,19,20,28</sup> Among them, three teams considered the validated threshold (RFS > 7) for the suspicion of the diagnosis.<sup>17,19,20</sup> The RSI > 13 and RFS > 7 association was considered

for suggesting the LPRD diagnosis in one study.<sup>20</sup> An objective LPRD approach was used in two studies.<sup>21,23</sup> Lloyd et al documented LPRD through the use of 18- to 24-hour oropharyngeal pH testing,<sup>21</sup> while Loo et al measured salivary pepsin concentration in singing students with the Peptest® device.<sup>23</sup>

## PREVALENCE OF REFLUX SYMPTOMS AND FINDINGS IN SINGING POPULATIONS

### THE PREVALENCE OF REFLUX SYMPTOMS OR FINDINGS HAS BEEN INVESTIGATED IN THE THREE ABOVEMENTIONED SINGER POPULATIONS

In singers without voice symptoms at the time of the evaluations, some laryngeal signs suggestive of LPRD have been reported in 18.1%-73.4% of cases,<sup>12,16</sup> while RSI > 13 was documented in 10%-17%.<sup>16</sup> Hočevár-Boltežar et al suggested that choristers had higher RSI scores compared with soloists.<sup>16</sup> Based on the detection of oropharyngeal acid, weak acid, or alkaline reflux events at the oropharyngeal pH testing, Lloyd et al reported that 95% of professional singers had LPRD regardless of symptoms.<sup>21</sup>

Laryngeal findings associated with LPRD have been investigated in populations of singers consulting with voice complaints.<sup>19,26,28</sup> LPRD-laryngeal findings were found in 33%-90.3% of cases, depending on the clinical assessment method. Among this group of studies, RFS > 6 was detected in 33% of professional singers,<sup>28</sup> and RFS > 7 was found in 69.0%-90.3% of singing students.<sup>19</sup>

In the general population of singers, including singers with or without voice complaints, the pepsin was detected in the saliva of 97% of singing students, which was significantly higher than controls (30%).<sup>23</sup> GERD or LPRD symptoms have been found in 25.0%-65% of singers.<sup>14,20,29</sup> However, the RSI was positive (RSI > 13) in 25.0%-33.9% of singers.<sup>20,29</sup> In the study by Nacci et al,<sup>20</sup> RFS was positive (RFS > 7) in 12.5% of singing students and 1.7% of controls. The same team showed that RSI and RFS scores were significantly higher in singers compared with controls. The higher prevalence of LPRD and GERD symptoms was corroborated in the study by Lenti et al who did not use validated PROM for assessing symptoms in professional choristers and soloists.<sup>22</sup>

Singer type has been suggested as an influencing factor in presenting reflux symptoms in two studies.<sup>15,22</sup> Pregun et al observed a higher proportion of heartburn, hoarseness, and regurgitations in choristers compared with controls, which was confirmed by Lenti et al, who did not observe significant differences in these symptoms between choristers and soloists.<sup>22</sup> However, the authors reported that soloists had higher scores of dysphagia compared with choristers.<sup>22</sup> The differences between choristers and controls were not significant in the study of Robotti et al for RSI and history of reflux medication.<sup>18</sup>

The findings of the study of Santos et al attributed the higher proportion of reflux symptoms in singers to the consumption of alcohol,<sup>24</sup> while Zuim et al found a link between the history of reflux disease and the development of vocal fold pathology.<sup>27</sup> Concerning other reflux outcomes, Mavraj et al reported that 29.9% of professional or amateur singers take antireflux medication.<sup>13</sup>

## **BIAS ANALYSIS**

The MINORS evaluations are available in [Table 3](#). The MINORS ranged from 8 to 14, meaning that no study reached the ideal MINORS score for cross-sectional, uncontrolled, or controlled studies.<sup>11</sup> The study aim, and the prospective data collection (including cross-sectional studies) scores were high in most studies ([Table 3](#)). There was no study recruiting consecutive singer patients. The appropriateness of endpoints was judged adequate in two studies using objective testing for detecting LPRD.<sup>21,23</sup> In three studies,<sup>22,24,27</sup> the endpoint and outcomes evaluations were inaccurate due to the lack of validated PROMs, or the lack of objective evaluation. The analysis of other studies suggested that the appropriateness of assessed endpoints was moderate because the authors performed only laryngeal evaluation,<sup>12,17,19,26,28</sup> laryngeal and symptom evaluation without a validated clinical instrument or with only one validated instrument for symptoms or signs,<sup>14,16,18,25,29</sup> and the use of two validated subjective instruments but not objective testing.<sup>20</sup>

Note that in some studies, for example, the study of Mavraj et al,<sup>13</sup> the objective of the study was not the investigation of reflux disease, which may explain the low MINORS in that review. The study of Myint et al was the only one with < 5% of subjects lost to follow-up or individuals who did not complete the evaluation.<sup>19</sup> There was no study assessing study size population calculation, while the statistical analyses were judged as adequate in 17/18 studies ([Table 3](#)). Among controlled studies, the control groups included non-singer individuals, which explains the low MINORS subscore of most studies. The control and patient groups were comparable in the study of Nacci et al,<sup>20</sup> while in the others, there were no baseline comparisons of confounding outcomes (eg, demographics, tobacco, alcohol overuse, allergy, and comorbidities),<sup>15,16,22,23</sup> making it difficult to determine through bias analysis whether the groups were comparable. The study and control groups of Robotti et al were considered noncomparable because controls included a higher proportion of smokers, drinkers, and late-night dinners.<sup>18</sup>

The heterogeneity among studies in inclusion/exclusion criteria, reflux diagnoses, and singer profile outcomes precluded statistically pooling the data into a formal meta-analysis, thereby limiting the analysis to a qualitative rather than quantitative summary of the available information. Finally, the profile of singers and the voice range/classification were detailed in 6/18 studies.<sup>12–14,18,19,22</sup>

## DISCUSSION

Singers represent a population at risk for vocal fold pathologies due to vocal strain, dietary habits (late-night eating), stress, and anxiety patterns.<sup>5,6,32</sup> Thus, singers are 1.7 times more likely to have a history of vocal impairment and they were twice as likely to have had a previously diagnosed voice problem compared with nonsingers.<sup>33</sup> In this context, the detection of triggers and conditions that compromise vocal fold tissue is an important issue in laryngology. The backflow of the gastroduodenal content into the larynx (LPRD) is considered important in impairing the vocal fold mucosa and healing in the development of laryngeal pathology.<sup>3,34</sup>

The data of the present review might suggest that reflux symptoms and findings are more prevalent in singer populations compared with non-singer controls. However, many biases have been identified, limiting the establishment of real prevalence or incidence of LPRD.

First, most studies were cross-sectional surveys documenting the LPRD on validated or unvalidated PROMs without objective testing. Symptoms associated with LPRD are nonspecific, and they can be found in many conditions associated with irritation of the upper respiratory mucosa, eg, allergy, laryngopharyngeal infection, alcohol-/tobacco-induced laryngopharyngitis, or chronic rhinosinusitis with postnasal drip.<sup>35–38</sup> Therefore, control of confounding conditions or additional diagnoses with nonspecific laryngopharyngeal findings remains important when the LPRD assessment is based only on symptoms and findings.<sup>39</sup> Tobacco use, alcohol consumption, and allergy were documented in only two studies before the clinical evaluation of reflux.<sup>21,24</sup> Conversely, some confounding conditions or additional diagnoses with nonspecific laryngopharyngeal findings were not controlled or matched between singer and control groups in some studies,<sup>6,15,16,22,23</sup> which can bias the laryngopharyngeal symptom and finding evaluation. For example, Robotti et al did not report significant RSI differences between singers and controls, but the proportion of smokers and drinkers was higher in the control group compared with the singing group. A higher proportion of smokers and drinkers, and potential tobacco- or alcohol-induced laryngopharyngitis in the control group, could account for significant differences in the RSI between choristers and controls.<sup>18</sup> Controlling some reflux triggers is challenging for singers, given their lifestyles. Moreover, the use of 24-hour HEMII-pH is still difficult because singers are reluctant to be submitted to pH-metry, fearing throat injuries.<sup>14</sup> Thus, some noninvasive objective approaches could be used to support the diagnosis, such as measuring gastroduodenal enzymes in the saliva.<sup>40,41</sup>

**TABLE 3.**  
**Bias Analyses**

References	Clearly Stated Aim	Consecutive Patients	Prospective Data Collection	Endpoints Appropriate to Study	Unbiased Endpoint Assessment	Follow-Up Adequate Period	< 5% Lost to Follow-Up	Study Size Population Calculation	Adequate Control Group	Contemporary Groups	Baseline Group Equivalence	Adequate Stat Analyses	Total MINORS Score
Lundy et al <sup>12</sup>	2	0	2	1	1	-	-	0	-	-	-	2	8/14
Heman et al <sup>14</sup>	2	0	2	1	1	-	-	0	-	-	-	2	8/14
Pregun et al <sup>15</sup>	2	0	2	0	0	-	-	0	1	1	1	2	8/24
Hocevar et al <sup>16</sup>	2	0	2	1	1	-	-	0	1	1	1	2	11/20
Sataloff et al <sup>17</sup>	2	0	2	1	1	-	-	0	-	-	-	2	8/14
Robotti et al <sup>18</sup>	2	0	2	1	1	-	-	0	1	2	0	2	11/20
Myint et al <sup>19</sup>	2	0	2	1	1	2	2	0	-	-	-	2	12/18
Lloyd et al <sup>21</sup>	2	1	2	2	2	2	-	0	-	-	-	2	13/16
Nacci et al <sup>20</sup>	2	0	2	1	1	-	-	0	1	2	2	2	13/20
Loor et al <sup>23</sup>	2	0	2	2	2	-	-	0	1	2	1	2	14/20
Santos et al <sup>24</sup>	2	0	2	0	0	-	-	0	-	-	-	2	6/14
Lenti et al <sup>22</sup>	2	0	2	0	0	-	0	0	1	2	1	2	10/22
Nacci et al <sup>25</sup>	2	0	2	1	1	-	-	0	-	-	-	2	8/14
Zuim et al <sup>27</sup>	2	0	2	0	0	-	-	0	-	-	-	2	6/14
Korn et al <sup>26</sup>	2	0	2	1	1	-	-	0	-	-	-	0	6/14
Mavreji et al <sup>13</sup>	2	0	2	0	0	-	-	0	-	-	-	2	6/14
Campagnolo et al <sup>28</sup>	2	0	0	1	1	-	-	0	-	-	-	2	6/14
Nacci et al <sup>29</sup>	2	0	2	1	1	-	-	0	2	2	1	2	13/20

**Singer Reflux Symptom Score (Singer RSS).**

Symptoms	Severity	Frequency	Quality of Life Impact
	Total score:.....	Total score:.....	Total score:.....
1. I suffer from hoarseness	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
2. I suffer from voice breathiness	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
3. I have difficulty in reaching high notes/pitch	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
4. I must do additional effort during singing	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
5. I have a lack of voice power	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
6. I have a lack of vocal resistance and I have vocal fatigue	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
7. I have excess throat mucus	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
8. I have excessive throat or mouth dryness	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5
9. Other: .....	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5	0 - 1 - 2 - 3 - 4 - 5

**FIGURE 2.** *Singer Reflux Symptom Score (S-RSS).* Severity of symptoms is assessed from 0 (= no problem) to 5 (= problem is very troublesome when it occurs). Frequency is assessed from 0 (= no problem) to 5 (problem occurs 1 = 1-2 times weekly, 2 = 3-4 times weekly, 3 = 5-6 times weekly, 4 = one time daily, 5 = several times daily). The last evaluation concerns the impact of symptoms on quality of life (0 = no impact, 5 = significant impact).

Second, this review showed that validated singing PROMs were used concurrently with reflux evaluation in only one study,<sup>29</sup> while most authors evaluated the laryngopharyngeal symptoms with non-singing PROMs, such as RSI. The consideration of only classical reflux/symptom PROMs can be biased in the singer population because they present commonly singing symptoms related to the vocal fold irritation by reflux content, such as difficulty reaching high pitch or sticky mucous sensation.<sup>5,26</sup> While some singing voice PROMs exist, such as singing VHI,<sup>42</sup> it is important to note that, to date, there is no prospectively validated PROM dedicated to the assessment of reflux on the singing voice. Recently, Nacci et al proposed using the Singing-Voice Handicap Index-12-LPR, but this PROM was not prospectively validated in singers, which can limit its reliability and consistency.<sup>29</sup> Similarly, the Singer Reflux Symptom Score has been proposed but not yet validated (Figure 2).<sup>5</sup> The development of PROMs dedicated to singing symptoms related to reflux is an important step to improve the detection of reflux disorders in singers and, consequently, the quality of future studies.

Third, the review data reveal that the profile and features of singers (eg, experience, voice range/classification, gender, and habits) were heterogeneous in some studies or poorly documented in others. However, some singing features may influence the digestive, respiratory, and laryngeal physiologies and, consequently, the risk of reflux. This point was strengthened by Lenti et al, who reported some significant clinical differences between choristers and soloists in the clinical expression of reflux: soloists having more dysphagia than choristers.<sup>22</sup> In the same vein, Santos et al reported a significant impact of the consumption of alcohol on reflux-related respiratory symptoms in professional male singers.<sup>24</sup> Future studies are needed to investigate the potential influence of singing features on the development of LPRD symptoms and findings.

The low quality of most studies, the lack of consideration of objective, noninvasive reflux diagnosis approach, singing PROMs and singing features, and the heterogeneity across studies are the primary limitations of the present review. The lack of interrater reliability analysis between the laryngologist and the librarian and the lack of registration of this review in PROSPERO database are additional limitations. Yet, reflux symptoms and findings appear to be more prevalent in singer populations compared with controls, which can be related to several LPRD-contributing factors in singers, including lifestyle habits, increased intra-abdominal pressure from singing support, stress, anxiety, late-night dining, and sleep instability.<sup>18,29,32,43</sup> The systematic consideration of these contributing factors in future studies is essential for identifying reflux factors in at-risk populations. The report of singer features and habits is important. Pending the development of reflux-singing PROMs, the consideration of both classical reflux and voice symptom PROMs, singing voice PROMs, and multidimensional voice quality evaluations is mandatory to document the LPRD symptoms and their consequences on voice quality. Based on the findings collected in this systematic review, the authors have proposed a checklist of the key points to consider for the primary singer evaluation ([Table 4](#)).

**TABLE 4.**  
**Checklist for Key Points in the Analysis of Reflux in Singers**

Date of examination and physician I.D.	.....
Patient I.D.	.....
Birthday:	.....
Weight/Height:	.....
Job:	.....
Allergy:	Active/Inactive
.....	.....
Smoker (current Cig/d) and Smoking History (Paq. Year)	...../.....
CBI consumption	.....
Alcohol (unit/day)	.....
Coffee/caffeine drink/day	.....
Physical activity in leisure time	.....
Late dinner in the evening (n/week)	.....
Speaking vocal charge (0 = no voice use, 7 = high voice use)	.....
Medical or Surgical History (including laryngeal disease/surgery)	.....
.....	.....
.....	.....
Current medication/dietary supplement	.....
.....	.....
.....	.....
Current and past treatments for reflux disease	.....
.....	.....
.....	.....
Musical style (eg, Classical, Pop, Sacred, Choral, Theater, Rock, Show, Jazz, Gospel, Spiritual, Nightclub, Country, and Blues)	.....
.....	.....
.....	.....
Singer type (opera/classical—soloist, chorister)	.....
Voice range (soprano, mezzo-soprano, alto/tenor, baritone, and bass)	.....
Number of years of singing experience at first	.....
Singing habits	.....
Frequency of singing (daily, weekly, or monthly)	.....
Training in singing (total duration, type of training)	.....
Average duration of singing sessions	.....
Habit of performing with amplification (microphone)	.....
Warm up before singing	.....
Cool down after singing	.....
Involvement in professional singing activities	.....
(singing as a secondary source of income)	.....

Based on the findings collected in this systematic review, the authors proposed a checklist for key points to consider in the evaluation of singers. This checklist can lead to the conduction of a semistructured interview of singers.

## CONCLUSION

The prevalence of symptoms and findings attributed to LPRD is high in singer populations. However, the nonspecificity of symptoms and findings, the paucity of objective reflux testing, and the heterogeneity between studies limit the ability to draw valid conclusions about the prevalence of LPRD and its potential association with voice disorders in singers.

## Author Contributions

**Jerome R. Lechien:** Design, acquisition of data, data analysis and interpretation, drafting, final approval, and accountability for the work; final approval of the version to be published; agreement to

be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **Giovanni Briganti** (Librarian role): Acquisition of data, data analysis and interpretation, and final approval.

## Declaration of Competing Interest

About the paper entitled: “**Reflux disease in Singers: A Systematic Review.**” The authors have no financial interest in the subject under discussion. All authors have read and approved the paper.

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