The Influence of Age, Gender, Health-Related Behaviors, and Other Factors on Occupationally Relevant Health Complaints of Singers

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Summary: Objectives. Professional singers' careers are usually associated with health-relevant factors that they themselves may or may not be able to influence. We have therefore investigated the effect of modifiable health-related behaviors and non-modifiable factors on singers' occupational health.

Methods. In an explorative, questionnaire-based study, self-reported, occupationally relevant health complaints and behaviors, along with singer-specific characteristics, were surveyed from 349 professional singers and voice teachers (116 men, 233 women; age 18-73 years) and the influence of age, gender, duration of daily and lifelong singing, voice category, and health-related behaviors (smoking, alcohol consumption, physical activity) on occupationally relevant health complaints were analyzed using bi- and multivariate statistical methods.

Results. Singers reported less risky alcohol consumption (5.4% versus ≈15%) and smoking (15.5% versus 29.7%) than the general population, and too little physical activity was described in two thirds of both populations. After controlling for multiple testing, no effect was found for these behaviors, the time spent singing daily, gender, or voice categories on singers' complaints. Health complaints were significantly fewer for males ($P < .001$) and older women and were reported more frequently for higher-pitched male voices, a trend not found in females.

Conclusion. Singers seem to smoke and drink less than members of the general population. These factors did not affect their complaints. Female singers described more work-related health complaints than males, a finding that corresponds to women in the general population. Older singers reported fewer complaints than younger singers, possibly because of selection effects or older singers acquiring strategies to avoid health-damaging behavior.

Key words: Singers−Occupational−Health−Gender−Age−Voice categories.

INTRODUCTION

The most important capital in the professional life of singers is their voice. Even minor recurring vocal problems, which are insignificant to those in most other professions, may result in serious professional and economic consequences.[1] Singers are therefore often concerned about their voices. A US-wide report indicated that professional singers accounted for 11.5% of phoniatric patients despite representing only 0.02% of the general population.[2] This means that the risk of a professional singer developing significant vocal problems was several hundred times higher than for a member of the general population.[2] A recent systematic review found self-reported prevalence values of voice disorders in singers and voice teachers ranging from 16.3% to 64.0%.[3] Nevertheless, due to competitive pressures, professional singers, especially freelancers, often perform even when their vocal, physical, or psychological condition is not optimal. This, in turn, can have a detrimental effect on their voices and well-being.[4–6]

Several different health complaints are occupationally relevant for singers. These complaints include stage fright and performance anxiety, which is also referred to as Music Performance Anxiety (MPA),[7] voice problems immediately after singing, recurrent upper airway infections,[8] and a number of other complaints. Although moderate amounts of MPA can be experienced positively, higher amounts represent a pathological condition and require specific treatment.[7] MPA usually occurs immediately before or during a performance, but may also be present anticipatorily days before.[9,10] It can affect technical performance, mainly via increased sympathetic nervous system activity accompanied by increased muscle tension.[11] According to a systematic review, the prevalence of MPA in musicians ranges from 16.5% to 60.0%.[9] Vocal problems after singing may be caused by vocal overload, often associated with edema, swelling, and hemorrhage of the vocal folds,[12,13] or by inefficient vocal technique.[14] Recurrent airway infections pose a considerable threat to a vocal performer's professional life[13] and could lead to hemorrhage[12,13] or mucosal disruption[15]. Adults in the general population experience, on average, two to three upper airway infections per year.[16] There are no reports of a different incidence rate of such infections in singers.

Singers generally appear to face an increased risk of self-perceived dysphonia and voice-associated somatic and

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psychosomatic complaints than non-singers.[1–3] The occupational relevance of professional singers' vocal and non-vocal complaints may be determined by several factors, some of which could be the same as those that influence general health; others may be specific to singers. Some factors may be modifiable, others not. Modifiable factors that directly affect both general health and voice[17–21] include smoking,[22–24] alcohol consumption,[23,25] and physical activity. eg, smoking, in addition to general health risks,[26,27] leads to an increased risk of chronic inflammatory mucosal changes in the larynx and thus increased occurrence of Reinke's edema.[28,29] Alcohol consumption, on the other hand, can lead to voice impairment via dehydration, changes in the properties of the vocal fold mucosa, or decreases in muscle activity and physical control of the vocal system.[17,18] Conversely, physical activity typically benefits not only general physical health and well-being,[19,20] but also vocal function.[21]

Non-modifiable factors that strongly influence general health include age and gender. Women, for instance, express more subjective health complaints than men, are more likely to use health services,[30] experience more psychological distress,[31] and show greater perception of pain.[32] Age and gender have also been associated with vocal health.[30–33] eg, increasing age has been reported to have a negative impact on vocal health and women are reported to be more susceptible to dysphonia than men.[33]

Two factors that are specific to singers and may affect their occupationally relevant health complaints are the amount of time spent singing per day and the amount they have sung throughout their lives.[34] The first is modifiable; the second is not. One usually non-modifiable factor that can influence vocal health, specifically in classical singers, is voice category (ie, soprano, mezzo-soprano, alto, tenor, baritone, and bass). Various morphological and physiological characteristics of vocal folds differ between these voice categories, such as length and elasticity,[35] resonance and register strategies,[36] and, possibly, the demands placed on the voice-generating and voice-shaping organs, the latter of which could make them differentially susceptible to voice damage. As an example, biomechanical studies have indicated that high voice pitch and the associated high mechanical stress on the mucosa and vocal ligament may be associated with increased tissue damage and thus discomfort.[37]

More knowledge about the factors that influence occupationally relevant health complaints is needed to provide singers with optimal prevention against them. The cross-sectional study presented here is intended as a contribution to this knowledge. It explored the distributions of the above-described possible determinants of occupationally relevant health complaints in a sample of professional singers and singing teachers and investigated the relationships between these factors and complaints. The number of the latter was captured by a score based on four kinds of complaints (a) MPA and other pre-performance complaints, (b) voice-relevant health complaints immediately after singing, (c) recurrent upper airway infections, and (d) other recurrent career-limiting health complaints.

MATERIALS AND METHODS

Questionnaire

A questionnaire was used for the study, with some items adopted from previously established health- and self-medication-related questionnaires[38,39] and others constructed in-house. The questionnaire had previously been tested in a sample of singers and singing teachers ($n = 20$) using a semi-structured interview based on its content and was subsequently optimized. It was administered as an interactive online tool using the open-source software LimeSurvey, in which participants' responses determined which questions were presented next (www.limesurvey.org).

The questionnaire items used in this study addressed several types of variables: (1) general characteristics of the study participants, (2) health-related behaviors, and (3) occupationally relevant health complaints. The general characteristics of the study participants included age, gender, voice category, years of professional singing and daily hours of singing. Health-related behaviors comprised smoking, alcohol consumption, and physical exercise. Occupationally relevant health complaints encompassed upper airway infections, health complaints directly before stage performance and vocal stress, health complaints after singing, and recurrent career-relevant health complaints. With the exception of alcohol consumption and upper airway infections, all variables were addressed by one question each. Alcohol consumption was assessed by two questions, one related to frequency (days per week), the other to the average amount per day on which alcohol was consumed (modified AUDIT test[40]). Upper airway infections were addressed by four questions that referred to frequency, duration, severity, and symptoms.

Study conduction and recruitment of participants

The study targeted professional singers and students whose field of study included singing as a main subject. Individuals who studied singing only as a part of their teacher training program were not included. Participants were recruited through an article in 'Vox Humana', the magazine of the German Association of Voice Teachers (*Bundesverband Deutscher Gesangspädagogen e.V.*), mailings to several German opera houses, conservatoires, professional choirs, and word of mouth. Singers who were willing to participate in the study were invited to send an email to the study center at the Dept. of Phoniatrics and Pedaudiology at Münster University Hospital. Accepted applicants were assigned a 15-digit access code for completing the online questionnaire. All participants gave their written consent in a digitally-presented consent form before filling in the questionnaire. Data collection was anonymous and in accordance with the Declaration of Helsinki.

Construction of variables

Health-related behaviors

Smoking was assessed in the questionnaire as a binary variable with two categories, 'smoker' and 'non-smoker'. This variable was directly used in the statistical analyses. In contrast, the variables on alcohol consumption and physical activity had to be constructed from the questionnaire information for statistical analysis.

Alcohol consumption was conceptualized as a three-categorical variable with the categories, 'no alcohol consumption at all', 'moderate alcohol consumption', and 'risky alcohol consumption'. The latter was defined as alcohol consumption more than twice a week and more than two standard glasses for women or, respectively, more than three standard glasses for men. One standard glass, in turn, was defined as being either 300 ml of beer, 100 ml of wine, or 40 ml of spirits according to German recommendations on limits for the consumption of alcoholic beverages.[41] These amounts correspond to the tolerable upper alcohol intake levels as determined by Burger et al.[42] of 10−12 g of alcohol per day for healthy women and 20−24 g for healthy men.

Physical activity was addressed in the questionnaire by asking about the frequency of exercise per week. This variable was transformed into a three-categorical variable for analysis using the categories 'health-endangering lack of physical activity', 'moderate activity', and 'health-supporting physical activity'. Health-endangering lack of physical activity was defined as physical activity occurring less than once a week, whereas health-supporting physical activity was defined as occurring twice a week or more, values which correspond to the World Health Organization's 'Global Recommendations on Physical Activity for Health'. According to these recommendations, adults aged 18 to 64 years should perform a minimum of 150 minutes of moderate-intensity physical activity per week in order to reduce major health risks. They should also include high-intensity training of major muscle groups on 2 or more days per week in order to increase fitness, stamina, and muscle strength.[43]

Complaints score

The questionnaire information regarding 'upper airway infections', 'health complaints directly before stage performance and vocal stress', 'health complaints after singing', and 'recurrent career-relevant health complaints' was aggregated into a single 'complaints score' which reflected the extent to which the individuals suffered from occupationally relevant health complaints. Two of the questionnaire items targeting these four areas were not binary questions ('upper airway infections' and 'health complaints after singing'). The answers to these questions were later mapped onto binary variables in order to enable a clear scoring system for analysis, using the following procedure. The items on frequency, severity, and duration of upper airway infections were mapped onto two categories, 'essential burden due to upper airway infections' (at least one infection of at least moderate severity and at least one week's duration, occurring at least once every three months) and 'no essential burden due to upper airway infections' (not meeting the above criteria), to form the binary variable for upper airway infections.

Answers to the original six-category frequency scale for 'complaints after singing' were transformed into a binary variable by mapping the first three categories ('never', 'seldom', and 'sometimes') onto the single category 'no essential complaints after singing' and the second three categories ('frequently', 'mostly', and 'always') onto the single category 'essential complaints after singing'. The final complaints score was then calculated by summing together the now-simplified scores for the four categories of reflected complaints ('essential burden due to upper airway infections', 'health complaints directly before stage performance and vocal stress', 'essential health complaints after singing', and 'recurrent career-relevant health complaints').

Statistical analyses

The first research question refers to differences between subgroups of singers. These sub-groups were the 2 genders and voice levels aggregated across genders (i.e. high voices [sopranos and tenors, typically female (f) and male (m), respectively], middle voices [mezzo-sopranos (f) and baritones (m)], low voices [altos (f) and basses (m)]). For these subgroups, differences with regard to general characteristics of the study participants and health-related behaviors were tested. For gender comparison, Fisher's exact tests was used for categorical variables and the *t*-test for independent samples without presupposing equal variances for continuous variables. Voice level comparison measures used the chi-square test for contingency tables for categorical variables, and analysis of variance for continuous variables.

The complaints score was bounded by 0 and 4, so the assumption of normally-distributed errors could not apply to this variable. Relationships with this score were therefore analyzed using cumulative logistic regression with enforced equal distance between the categories and using the complaints score as criterion. Altogether, the relationships with gender, voice level aggregated across gender, further general characteristics of the participants, and health-related behaviors were analyzed using both bivariate and multivariate analyses. In the latter case, all other variables were entered together in the same regression model. The multivariate analyses were performed to control for possible collinearities between the predictor variables and the bivariate analyses in order to provide results that are not dependent on the arbitrary decision as to what variables are entered into the multivariate regression model.

The bivariate and multivariate analyses were performed for the entire sample and for both genders separately. Gender differences with regard to the regression coefficients resulting from the multivariate analyses were tested by comparing the multivariate model for the complete sample with a model that additionally contained terms for the interaction between gender and the other predictor variables. When the second model reduced significantly more

deviance, this was taken as evidence for the prediction models for both genders being different.

Alpha-errors caused by multiple testing were controlled for by two approaches: a Bonferroni correction and a test of the joint effect of all predictors in the multivariate models. The first approach provides a very strong test, which gives high certainty that the effect passing this test is actually significant, whereas the second approach is a weaker test but gives chances to detect more results.

RESULTS

Of the 349 questionnaires completed, 2.9% of the data for variables addressing health-related behaviors and occupationally relevant health complaints were missing. The percentages of missing values range from 0% for smoking and amount of alcohol consumed, to 12.6% for complaints causing problems during the professional career. The majority of participants were women who belonged to the high voice group (see Table 1). The mean age of the study participants was 39.0 years, their professional singing careers had lasted on average 13.8 years (including studying at music conservatoires) and they sang on average 3.4 hours per day (see Table 2). Women differed significantly in age according to their voice level (ANOVA, $P < .05$), whereas men did not (see Table 2). Men with a high voice level were significantly older than women with a high voice level (t-test, $P < .01$) and had been singing professionally for longer than high voice women. All other between-subgroup comparisons, including the duration of daily singing, indicated no differences.

Only 15.5% of study participants smoked; the values for no, moderate, and risky alcohol consumption were 4.6%, 90.0%, and 5.4%, respectively; the values for health-endangering lack of physical activity, moderate activity and health-supporting physical activity were 31.2%, 35.0%, and 33.8%, respectively. Neither the 2 genders nor the different voice levels differed with regard to any of these three forms of health-related behaviors.

The mean number of health complaints was 1.60 (see Table 3), with women reporting clearly more complaints than men. This effect was statistically significant according to both the bivariate and multivariate analyses (see Table 4). After Bonferroni correction, the gender difference remains statistically significant, although only on the level of $P < .05$ for the multivariate analysis. Further essential differences between the bivariate and multivariate analyses are due to strong correlations between the variables investigated. The coefficient patterns produced by women and men in the multivariate analyses differ significantly ($P < .05$).

A gender difference was found between coefficient patterns regarding the relationship between voice level and complaints score. There is no statistically significant association for women, but there is one for men: men with low voices have significantly fewer health complaints than men with high voices. For middle voices the value is in between. However, the differences from the other two values just fail to be significant. Moreover, the effect for the low voices also does not remain statistically significant after Bonferroni correction. However, the joint effect of all variables applied as predictors in the multivariate model is statistically significant at the level of $P < .01$, and the P-values for both voice levels are by far the lowest out of all variables.

A further gender difference between the coefficient patterns relates to the relationship between age and complaints score. A highly significant effect was found for women, for whom complaints decrease with age. In contrast, there is no statistically significant age effect for men, although there is a tendency in the same direction as women. The effect for women even remains statistically significant at the level of $P < .001$ after Bonferroni correction.

A third gender difference was found between the coefficient patterns regarding the relationship between alcohol consumption and complaints score. Women with risky alcohol consumption reported significantly fewer complaints than abstinent women. The coefficient for moderate alcohol consumption lies in between and does not differ significantly from the coefficients for the other two categories. However, here there is no statistically significant effect for men and the tendency is in the opposite direction. The alcohol effect for women disappears after Bonferroni correction. The statistical significance for this variable might, therefore, be due to alpha-error.

TABLE 1.
Distribution of Sub-Groups*.

	Voice levels			
	High	Middle	Low	All
Women	Soprano	Mezzo-Soprano	Alto	
	146	67	20	233
	(75.3%; 62.7%)	(59.3%; 28.8%)	(47.6%; 8.6%)	(66.8%; 100.0%)
Men	Tenor	Baritone	Bass	
	48	46	22	116
	(24.7%; 41.4%)	(40.7%; 39.7%)	(52.4%; 19.0%)	(33.2%; 100.0%)
All	194	113	42	349
	(100.0%; 55.6%)	(100.0%; 32.4%)	(100.0%; 12.0%)	(100.0%; 100.0%)

* Numerical cell entries are: absolute frequency *(column percent; row percent)*

TABLE 2.
Basic Characteristics of the Study Sample*.

	Voice levels				
	High	Middle	Low	All	Tests†
Years of age					
Women	36.9 (9.8) 18-65	37.4 (8.7) 22-54	42.9 (8.6) 24-56	37.5 (9.5) 18-65	$P < .05$§
Men	42.4 (9.7) 26–70	40.9 (12.9) 21–73	43.9 (10.6) 26–73	42.1 (11.2) 21–73	not significant
All	38.2 (10.0) 18–70	38.8 (10.7) 21–73	43.4 (9.6) 24–73	39.0 (10.3) 18–73	$P < .05$§
Tests‡	$P < .01$§	not significant	not significant	$P < .001$‖	
Years of professional singing					
Women	11.9 (9.2) 0-40	12.3 (8.8) 0-35	17.2 (9.1) 3-30	12.5 (9.2) 0-40	not significant
Men	15.8 (9.1) 0–36	16.3 (12.4) 0–55	18.2 (12.4) 2–50	16.5 (11.1) 0–55	not significant
All	12.9 (9.3) 0–40	14.0 (10.6) 0–55	17.7 (10.9) 2–50	13.8 (10.0) 0–55	$P < .05$§
Tests‡	$P < .05$§	not significant	not significant	$P < .01$§	
Hours of daily singing					
Women	3.4 (1.8) 0.5–12	3.2 (1.7) 0.5–7	4.2 (2.3) 1.5–12	3.4 (1.8) 0.5–12	not significant
Men	3.3 (1.5) 0–6.5	3.3 (1.7) 0.5–7	3.3 (1.9) 0.5–7	3.3 (1.6) 0–7	not significant
All	3.3 (1.8) 0–12	3.2 (1.7) 0.5–7	3.7 (2.1) 0.5–12	3.4 (1.8) 0–12	not significant
Tests‡	not significant	not significant	not significant	not significant	

* Cell entries are: mean (standard deviation); *range*. As there are no missing data for the three variables considered, the sample sizes are identical to the corresponding numbers shown in Table 1.
† Test for differences between voice levels with ANOVA.
‡ Tests between genders with *t*-test for independent samples without presupposing equal variances.
§ = $P < .05$
‖ = $P < .001$

DISCUSSION

In this study, 349 professional singers and singing teachers from across Germany reported occupationally relevant health complaints and health-related behaviors, indicating the singers' alertness to occupational health problems and their desire for scientific explanations of them. Several factors indicate that this sample was representative of the broader population of professionally-experienced singers and voice teachers as a whole: the uniquely-large sample size, the gender distribution of males to females (1:2 which reflects the actual gender distribution of the professional guilds studied[44]), the long mean professional tenure (approx. 14 years), the duration of daily singing (consistently > 3 hours average), and the method of recruitment.

Gender and voice level effects

One of the key findings of our study is a highly-significant gender effect: women reported a distinctly higher average score on our measure of health complaints (mean 1.73 out of a maximum potential score of 4) than men (1.60). This is in line with studies showing a higher proportion of voice disorders in female singers than in male singers.[33,45] One explanation for this effect could be that female singers, regardless

TABLE 3.
Descriptive Values for Complaints Score*.

	High voices	Middle voices	Low voices	All voices
Women	1.74 (1.01)	1.70 (1.04)	1.75 (1.25)	1.73 (1.04)
Men	1.52 (0.90)	1.28 (1.07)	1.00 (1.07)	1.33 (1.01)
All	1.69 (0.99)	1.53 (1.07)	1.36 (1.21)	1.60 (1.05)

* Cell entries are: mean sum score; (standard deviation).

TABLE 4.
Associations Between Possible Determinants of Complaints and the Complaints Score*.

	Bivariate analyses‖			Multivariate analyses#		
	All	Women	Men	All	Women	Men
Male gender	-0.721§	—	—	-0.486‡	—	—
Voice level**						
Middle	-0.272	-0.068	-0.441	-0.193	-0.024	-0.588
Low	-0.583†	0.018	-0.978‡	-0.257	0.321	-1.051‡
Years of age	-0.049§	-0.048§	-0.040§	-0.052‡	-0.083§	-0.028
Years of singing	-0.045§	-0.038§	-0.045§	0.007	0.039	-0.027
Hours of daily singing	0.014	-0.032	0.118	0.023	-0.001	0.098
Smoker	-0.239	-0.171	-0.284	-0.397	-0.296	-0.525
Alcohol††						
Moderate	-0.470	-0.605	0.141	-0.310	-0.528	0.204
Risky	-1.182§	-1.811§	0.229	-0.614	-1.436†	1.089
Physical activity‡‡						
Middle	-0.059	-0.095	-0.052	-0.115	-0.085	-0.329
High	-0.083	0.036	-0.163	-0.030	0.117	-0.061

* Coefficients from a cumulative logistic regression model. These coefficients describe how the complaints score changes with a single-unit change of the variable in the first column. Deviations of coefficients from zero were tested statistically.
† = $P < .05$;
‡ = $P < .01$;
§ = $P < .001$.
‖ Only the variables in the respective row were entered together in the same regression model.
All variables were entered together in the same regression model.
** Reference category: high voice level.
†† Reference category: no alcohol.
‡‡ Reference category: low physical activity.

of voice category, generally sing on a higher pitch than males. Biomechanical studies indicate that high voice pitches, and the associated high mechanical stress placed on the mucosa and vocal ligament, may be associated with increased tissue damage and thus a higher number of health complaints.[37] In addition to the effect of absolute voice pitch, it could also be cautiously speculated that low-singing women (altos) have to master "dangerously" high passages more often than low-singing men (basses). This could be a reason why in our study an effect of voice pitch on the number of health complaints was observed only in men, with basses reporting significantly fewer complaints than tenors, a questionable effect, however, as it did not survive the Bonferroni correction.

The gender difference found in our study, however, can also be interpreted in a much wider context. Girls and women consistently report more health complaints than boys and men[46–49] and, in comparison with men, women report more limitations on health dimensions that are relevant for health-related quality of life.[50] This could perhaps be explained by females and males having different perceptual sensitivities. eg, women have lower somatosensory stimulus thresholds for mechanical pain sensitivity,[51,52] thermal detection,[53–55] and blunt pressure pain sensitivity[56,57] than men, as well as different somatosensorically controlled regulatory systems.[58] Equidirectional sex differences have been reported in children: girls tend to be more sensitive to thermal and mechanical stimuli than boys, with decreased detection thresholds for thermal and blunt pressure pain stimuli. Contrary to popular prejudice, hormonal factors seem unlikely to explain these sex differences as they have been observed both before and after puberty.[59] Genetic and psychological factors have been implicated as potential explanations for the central mechanisms mediating gender-different sensory and pain perceptions,[54,60,61] as have external socio-psychological influences on intra-individual, situational, positional, and ideological levels.[32]

Age effects

Age and, relatedly, the number of years of professional singing were other non-modifiable factor significantly associated with the complaints studied. Remarkably, across the complete sample, complaints decreased with age. However, in the gender-specific analyses this effect was statistically significant solely for women, although there was also a tendency in the same direction for men. The direction of this effect was surprising, as age has been found to have a negative effect on vocal health.[33] On the other hand, the complaints investigated in our study go beyond purely vocal complaints. A protective effect of age on health appears unlikely. Instead, a selection effect might explain this finding. Robust vocal health is a prerequisite for long-term professional success and frequent illness shortens the career. Older singers may therefore appear healthier within the collective of active singers. Singers might also learn to better prevent occupationally relevant health complaints with increasing age. However, we cannot exclude the possibility

that singers who had suffered from many occupationally relevant complaints may have given up singing as a profession and therefore did not feel addressed by the study call, leading to this group being underrepresented in our sample. The observation that complaints decrease with age especially in women could be explained by the above-mentioned gender effect. Females seem to be more aware of their health problems and seek strategies to avoid them, a tendency that is reflected, for example, in their higher readiness to participate in preventive medical checkups than men.[30]

Health-related behaviors

Gender and voice level are not associated with health-related behaviors such as smoking, alcohol consumption and physical activity within our sample. It is therefore probable that a sample with different distributions of gender and voice level would have produced, by and large, the same distributions for these three items of health-related behavior. This, in turn, increases the generalizability of our results and, thereby, justifies comparisons between the singer sample and the general population.

Taking this into account, our data suggest that professional singers have healthier lifestyles than the general population with respect to smoking and alcohol consumption. This may be due to greater awareness of these health-damaging factors by singers whose physical health is their professional asset. Only 15.5% (14.6% women; 17.2% men) of study participants smoked occasionally or regularly at the time of our study compared with 29.7% (26.9% women; 32.6% men) of smokers in the general adult population.[62] Because singers face a greater risk of developing vocal lesions due to increased vocal stress than the general population,[28] particularly benign vocal lesions (eg, Reinke's edema), and since smoking is an additional risk factor for these lesions[29] as well as for other diseases of the vocal and respiratory tracts, it therefore seems likely that knowledge of the deleterious effects of smoking on vocal health discourages singers from smoking.

Risky alcohol consumption has decreased among 18 to 59 year-olds in the general population over the last 2 decades but is still at 15.6% for men and 13.9% for women,[63] whereas only 5.4% of our study participants engaged in risky alcohol consumption. Knowledge of both the danger of alcohol addiction and risks of direct voice damage[23,25] may explain the greater reluctance of singers to consume alcohol at levels that present a risk.

The trend toward a healthier lifestyle among singers than in the general population was, however, not evident in rates of physical activity: approximately 1-third of singers in our study (31.8% female, 30.2% male) reported a health-endangering lack of physical activity (no or nearly no exercise), with moderate physical activity and health-promoting physical activity both also being undertaken by approximately one-third each of our sample. No gender or voice level differences were found for this factor. These values are similar to those found in the general German population: the Robert Koch Institute for Health reported that one-third of the Germans did no exercise (34.3% women, 34.2% men); 35% of women and 43.6% of men in Germany met the World Health Organization recommendation for regular physical activity in 2012 (GEDA report 2012).[64]

In recent years, the average level of physical activity in the general German population has steadily increased,[65] possibly reflecting an enhanced public awareness of its health-promoting effects. However, performing musicians typically have only moderate fitness levels, with singers being the most physically active group.[66] Regular physical activity would be advisable for singers, as it improves their overall health[19,20,67] and reduces the risks of mortality [68] and mental illness.[69] In addition, regular exercise specifically reduces the risk of dysphonia in occupations with high vocal stress.[70] A single bout of brief physical exercise also appears to benefit singing sound pressure levels and a singer's aerodynamic parameters,[21] although a one-time exercise does not appear to have a direct effect on acoustic voice quality.[71]

Remarkably, our study discovered almost no significant associations between health-related behaviors and the complaints score. The only exception to this was the counter-intuitive finding that women with risky alcohol consumption have fewer complaints. Various explanations could come into play for the relationship between the health-related behaviors and complaints studied: On the one hand, smoking, risky alcohol consumption and lack of physical activity may lead to more health complaints; on the other, increasing health complaints may result in individuals smoking less, reducing their alcohol consumption and increasing their physical activity. If these two effects are equally strong, no effect will be found in the coefficients. If the second effect is stronger than the first, the coefficients will point in the counter-intuitive direction of increasing health complaints. There is, however, vast empirical evidence that the second effect will not be very strong: past behavior strongly determines future behavior over and above psychological constructs such as intention to undertake a behavior;[72–75] changing behaviors such as smoking, alcohol consumption, or physical activity usually require a great deal of effort[76] and many interventions specifically devised to change behavior of this kind have no statistically significant effect.[77–79] Taking all of this into account, the lack of association between health-related behaviors and complaints in our study may be explained either by equally strong opposing effects or as a methodological artifact of the cross-sectional study design. The latter explanation may also apply to the counterintuitive finding that women with risky alcohol consumption report fewer health complaints than abstinent women, an effect that did not, however, withstand the Bonferroni correction and was not found in men. Although some protective health effects of low alcohol consumption, such as thromboprophylaxis, have been described, and particularly for females from locations with high overall development based on educational attainment, fertility, and income per capita,[80–83] negative health

consequences predominate especially for risky alcohol consumption.[84] An alternative explanation may include a possible alpha error stemming from a selection effect by which high alcohol consumption does not make women healthier but healthy women can afford to drink more.

Socio-economic and educational aspects

It is known that low socioeconomic status of individuals in a society[85] is associated, among other things, with a higher incidence of disease and health problems than for persons of high socioeconomic status—in the EU, for example, two to tree times higher.[86] Although we did not explicitly collect it, we assume that the participants in our study tended to belong to a higher socio-academic status group for the following reasons: Typically, professional singers have an academic degree or are in the process of attaining one; furthermore, our study participants were recruited primarily through opera houses and professional associations. Therefore, one might assume that their health complaints are somewhat lower than those of a comparable age group in the general population, even though the occupational health complaint status we surveyed cannot be directly compared to that of overall health complaints in the general population.

The presumably rather high social status of the participants might be one reason for the lower tendency towards smoking and drinking compared to the general population. People of lower socioeconomic status are more likely to smoke than those of higher status and find it more difficult to quit smoking in the longer term.[87] According to a study of adult health in Germany from the same study period as our survey, ex-smokers, as measured by persons who ever started smoking, accounted for 35.8% of 18- to 79-year-old women of low socioeconomic status, compared with 61.8% of women of that age in the high-status group. Among men, these differences are similarly pronounced, with values of 42.8% in the low status group and 65.6% in the high-status group.[62] In addition, preventive measures are less effective for individuals from low socioeconomic backgrounds.[87] The most likely preventive effect is generated by price increases for tobacco products, ie, measures with a direct economic impact on the target group.[87] In contrast, an additional economic factor probably has a strong preventive effect on singers, namely the threat of loss of earnings as a consequence of smoking.

A low socio-economic status is known to be associated with increased alcohol-related-health-harms in the general population.[80,88] Since a rather high social status may be assumed for our study sample, the described contrast between it and the general population regarding risky alcohol consumption might have been somewhat weaker if we would have adjusted for socio-economic status.

LIMITATIONS

Some limitations apply to the interpretation of our results: firstly, questionnaire return rates could not be determined because participants were recruited via an open call. Unknown sample selection factors may therefore have been present. One example of such a bias could be, that professional singers and singing teachers who had ended their careers prematurely because of health problems may not have felt addressed by our call and could be underrepresented in the data set. This potentially substantial group could have contributed important insights into our research and should be considered in future studies.

The second limitation is that, given that educational level and socioeconomic status influence health-related behaviors, our sample consisted predominantly of individuals with college degrees. This therefore has the potential for bias when comparing with the general population. The study sample does, however, appear to be representative of professional singers and singing teachers in Germany in terms of size, recruitment method, and gender distribution.

The third limitation is that our study did not include physical health examinations, which would have been difficult to collect and, at best, only possible in a small sample. Analysis of health insurance data as an alternative to this would also have been difficult to obtain and probably not very representative.

These limitations are counterbalanced by the benefits brought by this nationwide survey of the long-term, retrospective, self-perceived, occupationally relevant health status of a large number of singers. This research is valuable because individuals with subjectively reported negative health status are at higher risk of physical and cognitive dysfunction,[89,90] mortality,[91] have greater need of medical care, and, thus, create greater health-care costs[92] than those without. The ICF (International Classification of Functioning, Disability and Health) criteria[93] state that limited subjective well-being and quality of life also have disease value and should consequently be the object of research. The fact that our study data consists of individual assessments of discomfort is consistent with these ICF criteria and underlines the validity this work.

CONCLUSIONS

Surprisingly, modifiable behaviors that generally have a high impact on both vocal and general health, such as smoking, risky alcohol consumption, and physical activity, have hardly any effect on the occupational health complaints of singers studied here. One reason for this may be that singers appear to smoke and drink less than the general population, but individuals who drink and smoke to the extent that their health complaints would be exacerbated are most likely underrepresented in the study sample. Too little physical activity is reported equally in our sample and in the general population.

Similar to the general population, where health complaints are more likely to be perceived by women than by men, female singers report more occupationally relevant health complaints than male singers. The older singers are and the longer they have sung professionally, the less they perceive health problems that could jeopardize their

professional practice and career. Whilst this could be due to a selection effect (only singers with robust professional health remain in the profession and those who left due to frequent illness may not have participated in the study), it could also reflect a genuine positive effect of strategies learned in order to prevent complaints. Although identifying such strategies requires further research, the gender effects found in our study already provide hints towards them. Complaints expressed by female singers should be taken seriously and male singers could be encouraged to develop a higher awareness of their complaints and actively seek strategies for prevention. Optimizing health care for professional singers requires a shared understanding of the considerable mental and physical demands of the profession and sensitivity on the part of health professionals to both the objectifiable and subjective complaints of singers.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at doi:10.1016/j.jvoice.2021.08.001.

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