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The Effectiveness of a Voice Training Program for Telemarketers

***Andréa Gomes de Oliveira, †Nelson Gouveia, and ‡Mara Behlau,** **Rio de Janeiro, †‡São Paulo, Brazil*

Summary: Purpose. To use a randomized design to evaluate the effectiveness of voice training programs for telemarketers via multidimensional analysis.

Methods. Forty-eight telemarketers were randomly assigned to two groups: voice training group (n = 14) who underwent training over an 8-week period and a nontraining control group (n = 34). Before and after training, recordings of the sustained vowel /ɛ/ and connected were collected for acoustic and perceptual analyses.

Results. Based on pre- and posttraining comparisons, the voice training group presented with a significant reduction in percent jitter ($P = 0.044$). No other significant differences were observed, and inter-rater reliability varied from poor to fair.

Conclusions. These findings suggest that voice training improved a single acoustic dimension, but do not change perceptual dimension of telemarketers' voices.

Key Words: Voice–Voice training–Effectiveness–Preventive medicine.

INTRODUCTION

Voice training programs have been previously shown to prevent vocal fold lesions because of voice misuse and abuse, and to improve overall voice efficiency.[1] However, there are few randomized, controlled studies evaluating the effectiveness of these programs,[2–4] particularly for vocally high-risk populations in which the prevalence of aberrant voice symptoms is high, as in telemarketers.[5,6] Such studies overwhelmingly favor the implementation of vocal health promotion programs[7] for the prevention of voice disorders.[8]

A recent review of the literature regarding the impact of such training programs on voice quality revealed 10 related studies.[9] Of the 10 studies, nine reported statistically significant improvement in at least one measure related to voice production compared with baseline. Two of the studies specifically targeted telemarketers.[10,11] Although the results were favorable in this population, neither of the studies met the appropriate methodological criteria to confirm validity, as outlined by the authors themselves who recommended future controlled, randomized clinical trials and an investigation regarding different types of vocal training programs.

The same authors recently published qualitative and quantitative research protocols,[12] which were applied to telemarketers and managers from 13 call centers from the United Kingdom and Ireland.[9] Specifically, the study investigated the context of work and communication demands in telemarketers, performed vocal health assessments, and identified risks and the need for training in this population. From the responses of the online confidential questionnaire completed by 598 telemarketers, 25% of the participants reported poor vocal health behaviors, 25% reported muscle tension symptoms, 11% reported a confirmed diagnosis of underlying their dysphonia, and 10% reported that voice problems impact work. Acoustic analysis confirmed that, at the end of a call, telemarketers' voices may be rough, fatigued, and/or inconsistent with regard to pitch. The authors reported that participation in training reduced the risk of dysphonia, and they recommended vocal training for all telemarketers, especially for those early in their career, and vocally based strategies to reduce or eliminate absenteeism.

The present study sought to evaluate the effectiveness of a voice training program for telemarketers. Specifically, the authors sought to compare telemarketers placed in a training group (intervention) with nontrained telemarketers (control group) on several variables including auditory-perceptual and acoustic parameters before and after training. We hypothesize that a voice training program can help to maintain or improve the telemarketer's voice quality.

METHODS

This present study was approved by the Ethics in Research Committee of the Medical School of University of Sao Paulo in accordance with the ethical aspects recommended by the 196/06 resolution from the National Health Council regarding research involving human subjects (Brazil, 1996). All subjects provided informed consent.

Subjects

Subjects in the present study were telemarketers between 18 and 55 years of age currently performing receptive (those telemarketers sought out by customers), active (those telemarketers seeking out customers), or hybrid telemarketing (a mix of both receptive and active) for at least 6 months.[13] Inclusion criteria included an average of 6 working hours per day. Potential subjects who received previous vocal training were excluded. A telemarketing service company located in the state of Sao Paulo that employed approximately 700 telemarketers was selected for this study.

Data collection

Of the 700 telemarketers currently employed at the company, 229 were considered eligible. The final sample size was

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From the *Universidade Veiga de Almeida, Rio de Janeiro, Brazil; †Departamento de Medicina Preventiva, Faculdade de Medicina, Universidade de São Paulo, São Paulo, Brazil; and the ‡CEV, Centro de Estudos da Voz, São Paulo, Brazil.

Address correspondence and reprint requests to Andréa Gomes de Oliveira, Rua Magno Martins, 128, apto 121 – Freguesia, Ilha do Governador, Rio de Janeiro 21911-430, Brazil. E-mail: agoaoliveira@gmail.com

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determined based on the estimated improvement associated with the training program. It was estimated that telemarketers receiving training will display a 50% improvement in the number of vocal symptoms based on previous work by Timmermans.[14] Considering that nontrained telemarketers would display a 20% improvement, a type I error of 5%, and power of 80%, we estimated a sample size of 45 telemarketers in the intervention group and 45 in the control group, totaling 90 telemarketers, but a sample of 120 eligible employees was randomly selected to account for attrition. These professionals were invited to participate in a 30-minute vocal hygiene lecture, which was not a component of the training program. The goal of this lecture was to increase interest in the present study and enhance adherence to the study protocol. During the lecture, the telemarketers were informed of the study and its objectives, and they were given the opportunity to consent to participate at the conclusion of the lecture.

A total of 100 telemarketers (83.3%) attended the lecture, of which 92 (76.6%) consented to participate in the present study. Subjects were then randomly assigned to an intervention group (n = 44) and a control group (n = 48). The intervention group received an 8-week training program, including vocal warms and cooldowns, and tasks to expand the psychodynamic aspects of voice production. To be included in the present study, telemarketers had to attend at least 6 (75%) of the 8 training program sessions that were offered once a week and directed by the voice pathologist responsible for the study. All subjects were evaluated via both perceptual and acoustic analyses, before and after training, as described in the following sections. After the completion of the study, the telemarketers in the control group were provided with the vocal training program, if they were interested.

Procedures

Multidimensional voice evaluation consisted of acoustic and perceptual measures collected before and after training. In addition, some demographic and voice information was obtained to characterize the sample, and to compose matched control and intervention groups, including sex, age, level of education, presence of any voice complaint, sore throat, general propensity to scream or speak loudly, involvement in any activities requiring intense voice use, heartburn, hoarseness waking, stomach pain, frequent colds, food before bedtime, hearing loss, thyroid dysfunction, arthritis, lung disorders, allergies, smoking, former smoking, alcohol use, homemade products for voice disorders, medications in general, and how the telemarketer consider the workplace humidity. Some of them are going to be present on results. Finally, subjects were asked if they have a history of voice problems, and if they received treatment. This final item was used to determine if subjects had received formal or allopathic treatments for laryngitis, infections, or allergies that may have caused voice problems.

Initially, the groups were compared with regard to demographic and voice dimensions. As shown in Table 1, the groups were considered similar. Voice samples were captured directly in a microcomputer. These were stored in *Voxmetria* software (CTS Informática, Brazil) at a sample frequency of 44,100 Hz. The recording took place in a silent room (with noise level under 50 dB) using a headset mono microphone, unidirectional, and with a plane response line (Plantronics Audio 20). The distance between the microphone and the telemarketers' lips was 10 cm for connected speech and 3–4 cm for sustained vowels. For both productions, a 45° mouth to microphone angle was used to minimize the erodynamic articulation noise.[15,16]

Voice samples consisted of a sustained vowel (/ɛ/) at comfortable pitch and loudness for acoustic evaluation, and counting

TABLE 1.
Demographic and Vocal Aspects of Telemarketers in the IG and CG

	IG		CG		Total	
Demographic and Vocal Aspects	N	%	N	%	N	%
Sex						
Male	5	35.7	5	14.7	10	20.8
Female	9	64.3	29	85.3	38	79.2
Escolaridade						
Completed high school	11	78.6	20	58.8	31	64.6
Incomplete higher education	3	21.4	12	35.3	15	31.2
University graduates			2	5.9	2	4.2
Age range (y)						
20–29	5	35.7	19	55.9	24	50
30–39	5	35.7	8	23.5	13	27.1
40–51	4	28.6	7	20.6	11	22.9
Voice complaints	2	14.3	12	35.3	14	29.1
Sore throat	3	21.4	6	17.6	9	18.7
Shouting or talking loudly	4	28.5	14	41.2	18	37.5
Another activity-intensive voice			2	5.9	2	4.2
Voice problem that required treatment	1	7.1	7	20.6	8	16.6

one to 10 for perceptual evaluation. The vowel /ɛ/ was chosen as it is oral, medium, open, and nonrounded and is used in most computerized acoustic analyses. For the sustained /ɛ/, the onset and offset of the production were excluded because of acoustic irregularity. All the samples were cut to 3 seconds, extracted from the first to the fourth second to measures of fundamental frequency, jitter, and shimmer, and the Phonatory Deviation Diagram (PDD) via *Sound Forge 7.0* software (SONY).

Perceptual analysis

Three evaluators (speech pathologists with expertise in voice) with greater than 5 years of experience in the evaluation and management of patients with voice disorders independently compared the telemarketers' voices pre- and posttraining. The tools most widely accepted are not sensible to evaluate slight changes on normal voices. Timmermans et al[14] found changes on the G score of GRBAS only after 18 months of training on students of acting and radio broadcasting. As this study aimed to assess the effectiveness of a program in the short term, the choice was made comparing the overall voice quality. Randomization of connected speech samples was performed. Recordings from each pair were presented in random order with regard to both timing and intervention (intervention or control group, and pre- or posttraining). Raters were instructed to select the best voice quality sample, or report that the productions were too similar to differentiate.

Acoustic analysis

F_0 (Hz), period perturbation quotient (PPQ) jitter, and energy perturbation quotient (EPQ) shimmer in percentage were compared, and the PDD pre- and posttraining. The PDD allows for a two-dimensional description and graphic representation of voice characteristics based on four acoustic parameters.[17–20] On the horizontal axis, three measures evaluate diverse aspects of signal regularity (jitter, shimmer, and wave form matching coefficient), and on the vertical axis, one measure captures noise in the acoustic signal (glottal-to-noise excitation [GNE]). Initially referred to as the Goettingen Hoarseness Diagram, the PDD was created by German researchers as a quantitative method to evaluate regularity and noise of sound signal.[17–19] The German group, which also described GNE, proposed that the relation between jitter, shimmer, and GNE as a reliable description of voice quality.[20] According to Madazio[21] and Madazio et al,[22] PDD accurately differentiates normal and deviated voices. Normal voices are placed inside the normality area and most of the deviated voices outside this same area.

Regarding jitter and shimmer, values were considered improved if the subjects performed lower than the mean of obtained differences after training. The obtained differences in mean values from posttraining compared with pretraining divided by the standard deviation, yielded adequate information to calculate effect size (ES). In PDD analysis, improvement was noted when there was a shift from outside to inside the normality or transition areas; regarding the quadrants, when there was a displacement from the right inferior quadrant, superior right or superior left to inferior left or transition (between any of the other three quadrants and the inferior left); regarding density when this one passed from broad to concentrated. Samples were considered poorer in the opposite scenario; changes to the presented above and the absence of changes when there was no difference in the three evaluated parameters. All analyses were performed by a trained speech pathologist, blinded to intervention, control group status, and to pre- and posttraining situation.

Voice training

The vocal training program was divided into eight 30-minute, weekly sessions or modules. The first three modules consisted of vocal warm-up. The fourth module included both vocal warm-up and cooldown. In the last four modules, activities included warm-up and group activities regarding the psychodynamics of voice production. To promote vocal warm-up and cooldown, the techniques of the voice training program described by Oliveira et al[23] were used. This program included facilitating sounds, body movement techniques with sound production, overarticulation exercises, pitch and loudness range exercises, semioccluded vocal tract exercises (hand-over-mouth technique),[8] and chant talk exercises.[24] The facilitating sounds included humming sounds associated with chewing movements, fricatives,[25] and voice sounds[26] associated with ascending musical scales (from C3 to C4) in staccato and legato.[8] For cooldown, voice sounds were also used, with descending musical scales (from G3 to C3), as well as the yawn-sigh technique[27] and laryngeal massage.[28]

The modules were conducted in an attempt to obtain insight into the participants' perception of their voice and potential problems. Analyses of the psychodynamic aspects of voice production were included; most notably, subjects were instructed to increase insight into voice production, specifically on the effect over the listener of the articulation type, loudness, vocal range, and body posture variations.[29,30] After performing the exercises, telemarketers consistently reported alterations in voice production, even without cuing. In the group activities, each subject analyzed results of different vocal performances to suggest that, which were more effective. Each subject received a program brochure, and every week a card was handed out for daily monitoring of compliance with the exercise program. The vocal psychodynamics work also included call simulations so that the telemarketers evaluated the impressions conveyed by different vocal behaviors, including changes in quality and vocal modulation, and in the elements of speech rate and articulatory precision.

Data analysis

Statistical analysis and the selection of telemarketers were performed via *SPSS* (v10.0; IBM, Armonk, NY). Subjects were selected by simple random sampling (using a random numbers table). The similarity between the groups and changes according to intervention were evaluated via Pearson's chi-square test. For all analyses, the level of significance was 5%. The intraevaluator reliability for the perceptual analysis was confirmed by calculating the percentage agreement obtained in the 11% of the repeated recordings. Inter-rater reliability was confirmed using the Weighted Kappa coefficient in *SAS* (8.0; SAS Institute Inc., Cary, NC). Altman's classification was chosen to interpret

this coefficient in which the values under 0.2 were classified as poor reliability, weak reliability from values 0.2 to 0.4, moderate reliability from values 0.4 to 0.6, good reliability from values 0.6 to 0.8, and above 0.8 as very good reliability.[31] For each acoustic measure, the ES was calculated according to the method proposed by Cohen.[34] Standard deviation of the pretraining mean (SE1) and the weighted standard deviation (SE2) were used. To interpret the results, when the variance between the deviations were homogenous SE1 was taken into consideration, otherwise, SE2 was analyzed. When SE1 and SE2 were lower or equal to 0.2, it was considered small ES, moderate until 0.5, and from 0.8 as large. The comparison test of PDD was the likelihood-ratio test (G test).

RESULTS

Of the 44 telemarketers in the intervention group, four changed positions, four were unavailable, 10 had an absentee rate of over 25%, and 12 failed to report for the study. The intervention group was, therefore, composed of 14 telemarketers. Of the 48 telemarketers in the control group, 39 attended the evaluations and 34 the reevaluations; a loss of 14 telemarketers. The sample was composed of 48 telemarketers, 14 in the intervention group, nine (64.3%) females and five (35.7%) males, and 34 in the control group, 29 (85.3%) females and 5 (14.7%) males.

After placing the telemarketers in the intervention group (IG, N = 14) and control group (CG, N = 34), the distribution regarding demographic and vocal characteristics was verified. Although the control group had a higher number of female telemarketers (CG = 85.3%; IG = 64.3%), in addition to decreased mean age and increased occurrence of voice symptoms (CG = 35.3; IG = 14.3), these differences were not statistically significant; the groups were considered similar with regard to the relevant variables ($P > 0.05$). Regarding voice characteristics, 18 telemarketers (37.5%) reported shouting or speaking loudly constantly, and 14 telemarketers (29.1%) had some vocal complaints or voice disturbance (Table 1).

To compare the pre- and posttraining perceptual analysis, the intra- and interevaluator reliabilities were assessed. Intraevaluator agreement was 80% for evaluator 1, 100% for evaluator 2, and 60% for evaluator 3. The Weighted Kappa coefficient confirmed poor reliability between evaluators 1 and 3 (k = 0.296), between the evaluators 1 and 2 (k = 0.116), and 2 and 3 (k = 0.083). In spite of the low intraevaluator reliability for evaluator 3, these data were included in the evaluation.

As shown in Table 2, the telemarketers were distributed into the intervention and control groups according to perceptual analysis, pre- and posttraining. There was no significant difference in voice quality pre- and posttraining ($P = 0.203$). In this stage, two telemarketers in the intervention group and three telemarketers in the control group were lost and speech samples were not obtained. The mean values and differences for F_0, jitter, and shimmer pre- and posttraining, and the ES obtained between the intervention (N = 14) and control groups (N = 33) are shown in Table 3. Decreased mean jitter values in the intervention group and the ES were considered small to moderate (ES1 = 0.28; ES2 = 0.33). An increase in mean shimmer values was noted in the control group, and the ES with weighted deviation was also considered small to moderate (ES2 = 0.43).

The mean of obtained differences in F_0, jitter, and shimmer measures pre- and posttraining, with respective confidence intervals (CIs), between the intervention and control groups are presented in Table 4. As the data had a normal distribution, a Student's *t* test was performed to confirm a statistically significant decrease in jitter values in the intervention group ($P = 0.044$). No significant changes were observed with regard to F_0 or shimmer ($P > 0.05$).

The telemarketers' distribution in the intervention and control groups according to increase or decrease in F_0, jitter, and shimmer measures pre- and posttraining are presented in Table 5. An increased number of telemarketers in the intervention group presented with decreased jitter values compared with the control group. This difference was statistically significant ($P = 0.028$) and suggests that decreased jitter associated with training is approximately four times greater (odds ratio [OR] = 4.4; CI = 1.13–17.03], suggesting higher regularity in glottic cycles. No differences with regard to F_0 and shimmer were observed.

The distribution of telemarketers in intervention (N = 14) and control (N = 29) groups regarding improved, worsened, and/or lack of graphic changes in PDD pre- and posttraining are shown in Table 6. Posttraining, more telemarketers in the control group presented with alterations in their graphics from the normality area or transition area to other quadrants or transition between themselves, but these shifts were not statistically significant ($P > 0.05$).

When comparing F_0, jitter, and shimmer, one subject in the control group was lost and a sample was not obtained for acoustic evaluation. In addition, five subjects produced phonation that was incompatible with the analyses and therefore, these samples were not included in the PDD analysis.

DISCUSSION

The present study sought to provide evidence regarding the effectiveness of a vocal training program for telemarketers, through a controlled and randomized study evaluating acoustic and perceptual voice dimensions. Therefore, it complements previous work evaluating the effectiveness of such programs regarding the occurrence of vocal attrition, using a self-evaluation questionnaire.[23]

TABLE 2.
Pre- and Posttraining Perceptual Evaluation of Telemarketers in the IG (N = 12) and CG (N = 31)

	IG		CG	
Perceptual Evaluation	N	%	N	%
Voice quality				
Pre best	3	25	10	32.3
Pos best	8	66.7	11	35.5
No difference	1	8.3	8	25.8
Disagreement	0	0	2	6.4

TABLE 3.
Mean Values and Differences of F_0, Jitter, and Shimmer Pre- and Posttraining and ES in the IG and CG

Acoustic Measures	IG							CG						
	Pre		Pos		Difference (95% CI)	ES		Pre		Pos		Difference (95% CI)	ES	
	Mean	SD	Mean	SD	Mean	ES1	ES2	Mean	SD	Mean	SD	Mean	ES1	ES2
F_0 (Hz)	168.5	44.5	167.9	41.7	−0.6 (−85.1 to 83.9)	0.02	0.01	182.4	31.3	183.8	31.2	1.4 (−59.8 to 62.5)	0.05	0.04
Jitter (%)	0.29	0.25	0.22	0.17	−0.07 (−0.48 to 0.34)	0.28	0.33	0.243	0.14	0.241	0.17	−0.002 (−0.9 to 0.29)	0.01	0.01
Shimmer	3.12	1.35	3.14	0.94	0.02 (−2.25 to 2.29)	0.01	0.01	2.99	0.79	3.46	1.32	0.47 (−1.7 to 2.6)	0.61	0.43

Abbreviations: SD, standard deviation; ES1, change in mean score divided by SD score pre (Cohen's d); ES2, change in mean score divided by the weighted SD (Cohen's d).

According to the demographics aspects collected, from the 48 telemarketers, 79.2% were female (64.6% are between 20 and 29 years and 35.4% had incomplete higher education or complete; Table 1). Algodoal[32] previously characterized this population; young females largely predominate the profession, likely because of the short working hours allowing adequate time for other activities. Furthermore, in Brazil, telemarketing has evolved as an ideal first job following high school. The predominance of females can be explained by a better adaptation of this group to the requirements of this profession how to stay hours at the same position and with constant monitoring.[33]

Regarding the vocal characteristics of this study, 37.5% of the subjects reported shouting and loud voice use constantly, both at work and in social scenarios. The use of voice at increased intensities may occur because of lack of appropriate auditory feedback in background noise and a potential compensatory behavior in the context of vocal fatigue as described by Koufman and Isacson.[35] As described by Hazlett et al,[9] it is important to highlight the relationship of telemarketers' occupational contexts as developing prevention strategies. Further investigation on these aspects will be presented in a future study. The percent of intrarater agreement, evaluated to express the intraevaluator reliability for the perceptual analysis varied from 60% to 100%, and the reliability between evaluators varied from poor to weak. Some factors may contribute to these values: 1) a predominance of telemarketers with normal voices in relation to deviated voices,[36] which may pose a limitation to perceptual analysis, 2) voice quality evaluation may favor a difference in voice analysis between evaluators, for example, one evaluator may prioritize resonance, whereas another prioritizes appropriate pitch, and 3) although there are no studies proving that intra- and inter-rater reliability may be influenced by expertise or evaluator training, this possibility may not be rejected. As voice evaluation of normal voices is more complex than deviated voices, one might consider training evaluators to increase reliability.[37]

Regarding perceptual analysis, although 8 (66.7%) telemarketers in the intervention group presented with improved vocal quality, there was no statistically significant differences between groups pre- and posttraining ($P = 0.203$). Timmermans[14] previously evaluated voice training program effectiveness on students of acting and radio broadcasting; students reported improvement after only 18 months of training. The author associated this result to low sensibility of the scale, as there was an improvement regarding acoustic indices and the Voice Handicap Index. In our study, it is possible that using a connected speech sample might not be adequately sensitive for perceptual analysis. In addition, the voice training might not produce a short-time change in perceptual analysis dimension as observed by Timmermans.[14]

Kreiman et al[37] verified that reliability and agreement, between and within raters vary from very low to extremely high. According to the authors, the large variability found is largely related to methodological issues, evaluations performed by the researchers themselves, and statistical errors. According to Södersten and Hammarberg,[38] the difficulty in evaluating normal voices may be explained by the limited variance of

TABLE 4.
Mean Differences (95% CI) in F_0, Jitter, and Shimmer Before and After Training in the IG and CG

	IG		CG	
Acoustic Measurements	Mean Differences	95% CI	Mean Differences	95% CI
F_0 (Hz)	3.17	−1.81 to 8.15	1.71	−2.76 to 6.19
Jitter (%)*	−0.18	−0.009 to 0.35	−0.007	−0.08 to 0.07
Shimmer	−0.26	−1.10 to 0.59	0.48	0.06 to 0.9

*$P = 0.044$.

vocal quality in people of the same age group and sex, as there is no proper scale to evaluate these voices. In a study using acoustic stimulus obtained from human voices, raters using a continuous scale performed better than raters using a six-point scale.[39] Some proposals of voice quality quantification, using breathiness, roughness, and tension parameters, are being evaluated.[40] In a study to evaluate the reliability of clinical self-evaluation scales, the authors found a strong reliability with the GRBAS[41] and CAPE-V[42] scales, but higher from CAPE-V than GRBAS.[43] Considering the necessary path to overcome these limitations, Oates[44] suggested the use of multiple methods to evaluate voice quality, including acoustic and self-evaluation protocols.

Regarding voice acoustic dimensions, a small to moderate improvement in short-term frequency perturbation measures, namely jitter was observed. Although both values, pre- and posttraining, are within the normal range, lower jitter values were observed consistently suggestive of a more stable signal. This finding also pointed out that the chance of decreased jitter associated with training is 4.4 times higher than with nontrained telemarketers. Within jitter, the ES varied from small to moderate. However, it is possible that this value is higher for some telemarketers because of increased deviation in mean jitter pre- and posttraining. With regard to shimmer, no statistically significant differences were observed, but the ES showed an association suggestive of the potential for increased values in nontrained telemarketers. These results may indicate a small to moderate shift within the range of normal.

TABLE 5.
Change in Values of F_0, Jitter, and Shimmer, Pre- and Posttraining Among Telemarketers From the IG (N = 14) and CG (N = 33)

	IG		CG	
Acoustic Measurements	N	%	N	%
F_0				
Reduction	6	42.9	14	42.4
Increase	8	57.1	19	57.6
Jitter*				
Reduction**	10	71.4	12	36.4
Increase	4	28.6	21	63.6
Shimmer				
Reduction	8	57.1	15	45.5
Increase	6	42.9	18	54.5

*$P = 0.028$.
**OR = 4.375 (1.1 to 17.0).

In analyzing the PDD graphics, the changes regarding area, quadrant, and density were not statistically significant between the groups. However, the control group had a higher number of telemarketers presenting with worsening graphics after the 8-week training. It is possible that these results were affected by the small sample size or that the period of 8 weeks may not be adequate to yield improvement in the intervention group.

In a previous study,[23] training had no effect on the number of vocal symptoms in telemarketers. However, an evaluation of risk suggested that likelihood of voice deterioration was 0.29 (CI = 0.11–0.77) when comparing trained and nontrained telemarketers. Although this difference was not statistically significant ($P = 0.054$), this result suggests that training may serve as a protection for telemarketers. Furthermore, more than 79% of the telemarketers reported an improvement in various voice and communication issues after training. These benefits were also evaluated via an adapted voice training questionnaire, developed by Lehto et al.[11]

In the present study, 92 telemarketers participated. Of this initial sample, only 52.2% of the telemarketers (n = 48, 14 in the intervention group and 34 in the control group) remained in the study. Attrition was associated with subject unavailability, dismissal by the company, and the schedule of the trainings (ie, trainings were not offered during work hours). Despite these factors, the number of voice symptoms reported by the telemarketers[23] was consistent with previous data.[5]

The training program may be considered effective with regard to some aspects of acoustic phenomena. Similar studies with larger samples are necessary to verify the significant changes occurring in the acoustic measures, specifically shimmer and PDD. Regarding perceptual analysis, new evaluation protocols must be developed to maximize inter- and intrarater reliability in this population. In addition, the statistical power of our study was likely diminished because of the small sample. To maximize subject compliance, perhaps the training should be performed during regular work hours. In addition, increased staffing may also yield more favorable results with decreased duration between accrual and the initiation of training. Furthermore, trainings could be performed by more than one professional[45] and the duration of the program may be altered to maximize the outcome.[46] These variables must be addressed

TABLE 6.
Changes in Phonatory Deviation Diagram Among Telemarketers of the IG and CG

Phonatory Deviation Diagram	Density*		Quadrant**		Area***	
	IG	CG	IG	CG	IG	CG
	N	N	N	N	N	N
Improvement	3	9	2	1	2	1
Worsening	1	4	1	5	2	6
No change	10	16	11	23	10	22

*$P = 0.571$.
**$P = 0.327$.
***$P = 0.427$.

to optimize intervention to account to significant attrition within the field. Finally, the diverse environment and ergonomic factors may affect the effectiveness of such measures in a call center; interdisciplinary work is necessary for these factors to be controlled and, if possible, eliminated.

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