Screening Index for Voice Disorder (SIVD): Development and Validation

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Summary: Purpose. To develop and validate a score that can serve as a screening index for voice disorders in teachers.

Methods. The subjects of this study were 252 female teachers, with and without voice disorders (WVD and WOVD) from the public school system of São Paulo, Brazil. All subjects underwent medical and vocal evaluations and completed a questionnaire about experienced vocal symptoms. They were then randomly divided into samples A and B. Sample A was used to develop and sample B to validate a Screening Index for Voice Disorder (SIVD). The development was done using a factorial analysis, and a cutoff point to predict the risk of having a voice disorder was defined using a receiver operating characteristic curve. The validation was done by calculating sensitivity and specificity values for the cutoff, comparing mean scores of subjects WVD and WOVD, calculating correlation between SIVD and Voice Handicap Index (VHI), and the association between the risk and presence of voice disorder.

Results. The SIVD comprised 12 symptoms and each accounts for 1 point on the scale. The cutoff to identify risk of voice disorder is five symptoms. Analyzing sample B, it was found that SIVD has good internal consistency ($\alpha = .82$) and sensitivity (94%), a strong correlation to VHI, significant association between risk of having and actual presence of voice disorder, and people WVD had higher mean SIVD.

Conclusion. The SIVD proved to be a reliable valid tool for the identification of voice disorders in teachers, especially for use in screenings, acting as an instrument of epidemiologic vigilance.

Key Words: Faculty–Voice–Voice quality–Voice disorders–Epidemiology–Questionnaires.

INTRODUCTION

Voice disorders are common among teachers, with prevalence in this population estimated in levels close to 60%.[1–3] It is acknowledged that voice disorders cause more absenteeism of teachers than they do for the general population and that they have a verified negative impact in their performance of classroom activities.[4]

The diagnosis of a voice disorder involves a series of specific procedures, which include medical diagnosis and vocal quality evaluation, that can only be performed by qualified professionals. The protocols most widely used in the assessment of voice tend to focus quality of life and the impact of the disorder in everyday and professional activities or they tend to aid in the evaluation of treatment outcomes.[5–8] Therefore, it may be said that these instruments are extremely useful for use in research and in clinical settings where voice disorders are being treated, but none of these measures have been specifically devised for screening purposes.

It is also known that not all teachers with symptoms related to vocal use have complaints or seek treatment or professional help, as these symptoms are sometimes considered as "normal" consequences of the profession. Therefore, periodic screenings in schools and other work environments would be advisable, so that eventual voice disorders have the earliest possible detection and adequate treatment.

However, there is a lack of validated instruments that are able to provide a reliable prediction of whether the individual has a voice disorder and that, upon a simple screening, is able to identify those who are at risk of having a problem, even if in its early stages.

The purpose of this study is to develop and validate a screening index for voice disorders in teachers.

METHODS

Subjects and data collection procedures

The subjects of this study were 252 female teachers currently teaching in the São Paulo city public school system. Initially, all teachers with vocal complaints who sought specialized assistance in a public city hospital were evaluated. When one teacher was diagnosed with a voice disorder, another teacher from the same school was randomly selected and asked to participate in the research. Compliance in this phase of the research was high, and only two of the contacted teachers denied participation. Upon attendance, this randomly selected teacher underwent the same assessment procedures. If a voice disorder was detected, this teacher was excluded from the study.

All participants in this study underwent a clinical laryngeal evaluation, including a direct laryngoscopy, performed by an otorhinolaryngologist. All examinations were conducted on the same day of the week, by the same ear, nose, and throat specialist, with more than 30 years experience. The presence of lesions, incomplete glottal closure, and visible signs of reflux on the vocal folds were the criteria used by the doctor to diagnose abnormal findings in the assessment.

The subjects also had their voices recorded, on the same day of medical examination, and these vocal samples were analyzed by three experienced speech-language pathologists, who

performed a perceptive-auditory assessment, using the GRBASI scale.[9] Voices with general grade of deviation (G) 0 were considered normal and those with general grade (G) ranging in between 1 and 3 were considered altered in the perceptual auditory assessment.

The teachers with abnormal findings in both medical and perceptive-auditory assessment were considered with voice disorder (WVD), and for the purpose of this study, the subjects with no abnormalities in their laryngeal examination and perceptive-auditory assessment of their voices were considered without voice disorder (WOVD). The combination of abnormal results in both perceptual auditory and vocal fold examinations to determine the presence of voice disorder was adopted to clearly distinguish both groups. All subjects with abnormal findings in either one of the evaluations received clinical treatment, even if the teacher had not been included in the study groups.

Furthermore, all participants completed a questionnaire comprised a list of 21 symptoms related to vocal use: hoarseness, voice loss, breaking voice, shortness of breath, high-pitched voice, low-pitched voice, high-low pitch variations in voice, weak voice, stinging throat, "sand grain" sensation in the throat, *globus*, phlegm, dry cough, cough with phlegm, pain when speaking, pain when swallowing, difficulty swallowing, sore throat, secretion/phlegm in throat, dry throat, and strained speech. This list comprised the symptoms found in the "voice symptoms and laryngeal-pharyngeal sensations" section of the full version of the questionnaire named Conditions for Voice Production-Teachers,[10] an instrument, which is widely used in Brazil. This is a questionnaire developed by a multiprofessional team, based on the records of several hundred teachers who sought specialized assistance due to voice complaints. Its 88 questions are divided into five different sections and were derived from the most frequent conditions reported by patients when referring to their vocal complaints. This questionnaire has not been validated and does not yet have a score, as its main purpose is to characterize different teacher populations. Another problem of using this questionnaire for screening is that it is long and therefore is not practical for rapid use and data analysis. However, the reproducibility of the section called "voice symptoms and laryngeal-pharyngeal sensations" varied from fair to strong in test-retest situation.[11]

The aforementioned section comprised the 21 symptoms, and each patient reported the frequency for each one on a 4-point *Likert* scale: *never*, *sometimes*, *almost always*, and *always*. An additional item on this scale consisted of the alternative "*I don't know.*" Answers *never*, *sometimes*, and *I don't know* were considered as an absence of that particular symptom (coded 0) and *almost always* and *always* accounted for a present symptom (coded 1).

Finally, all subjects completed Voice Handicap Index (VHI),[7] in its Brazilian Portuguese version.[12]

Those subjects who had abnormal findings in either one of the assessments but not on the other (eg, normal laryngeal examination but deviated vocal quality) were excluded from this study, as were those teachers who were not working directly in the classroom at the time of examination. The teachers WVD who did not seek professional aid but were part of the random selection process in schools were also excluded but received treatment when interested.

The data in this study were entered twice into the SPSS spreadsheet and compared through the *validate* resource of the *Epi Info* (version 6.4; Global-Manufacturer.com) software. Analysis was performed using *SPSS* for Windows (Version 16.0; IBM, Armonk, NY).

This study was approved by the Ethics and Research Committee of the Pontifical Catholic University of São Paulo under the protocol number 122/2011. All subjects signed an informed consent term, in which they agree to the use of their data for scientific research.

Score development and internal validation

To develop a score for the index, approximately half of the original sample was randomly selected and will hereafter be referred to as sample A (n = 130; 85 WVD and 45 WOVD). The data from the teachers in sample A were analyzed using a principal component analysis considering the 21 symptoms related to vocal use, mentioned previously. This analysis was performed using varimax rotation, and the selected factors were those with eigen value >1 and correlation coefficient greater than or equal to 0.50. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.725 and the Bartlett test of sphericity was statistically significant (chi-square = 217.200; df = 15; $P < 0.001$).

The score was named Screening Index for Voice Disorder (SIVD) and is calculated as the sum of symptoms reported as being present "almost always" and "always," among those selected by the factorial analysis.

A receiver operating characteristic curve was plotted to identify the best cutoff value to select individuals at risk of having a voice disorder. The internal consistency of this score was analyzed using Cronbach alpha coefficient (α). Therefore, the score's reliability in discriminating individuals WVD and WOVD was also assessed.

External validation

To perform the external validation of the data from 122 subjects remaining from the original sample were used. This group of subjects will henceforth be named sample B (n = 122; 73 WVD and 49 WOVD).

The PIVD score was calculated for each subject in sample B, and the internal consistency of the data was evaluated using Cronbach alpha coefficient (α). The mean scores and 95% confidence interval (CI) were also calculated for this sample, according to the presence or absence of voice disorder.

The sensitivity and specificity values were calculated for the cutoff value found in sample A (5 points).

The association between the risk of having a voice disorder as predicted by SIVD and the presence or absence of disorder according to the GRBASI scale was calculated using the chi-square test.

Finally, the concurrent validity was performed by calculating Spearman Correlation Coefficient (r) between SIVD and the values for each domain in VHI,[7,12] as well as for its total score.

RESULTS

Score development and internal validation

There were 130 teachers in sample A, with an average age of 40.6 years. Of these, very few subjects reported smoking (15; 11.5%). Most of the participants teach in elementary school classrooms (81; 62.3%) and work in between 21 and 40 hours a week (68; 52.3%). Most teachers in sample A have been working in this field for 16 or more years (74; 56.9%). The mean number of symptoms reported by the subjects in this sample was 7.2 (standard deviation [SD] = 3.5), with a median of eight symptoms.

In the medical examination of vocal folds, typical findings in this sample were vocal nodules, incomplete glottal closure, edema, and signs of gastroesophageal reflux on the vocal folds.

Of the 21 symptoms related to vocal use on the original list, 12 of them remained in the final version of the index after the principal component analysis. The index comprised a single scale that accounts for 42.878% of the cumulative variance. The 12 items that comprise the SIVD scale are: hoarseness, voice loss, breaking voice, low-pitched voice, phlegm, dry cough, cough with phlegm, pain when speaking, pain when swallowing, secretion/phlegm in throat, dry throat, and strained speech.

Each symptom reported as occurring almost always or always generates 1 point on the scale. The final score is obtained by the sum of all points obtained (number of present symptoms) and will therefore range from 0 (minimum) to 12 (maximum). The final version of SIVD is found in Appendix.

Cronbach alpha coefficient was $\alpha = .86$, which represents a good level of consistency among the 12 symptoms on the scale.

A receiver operating characteristic curve (Figure 1) was plotted to determine the best cutoff point when identifying the individuals who were at risk of having a vocal disorder.
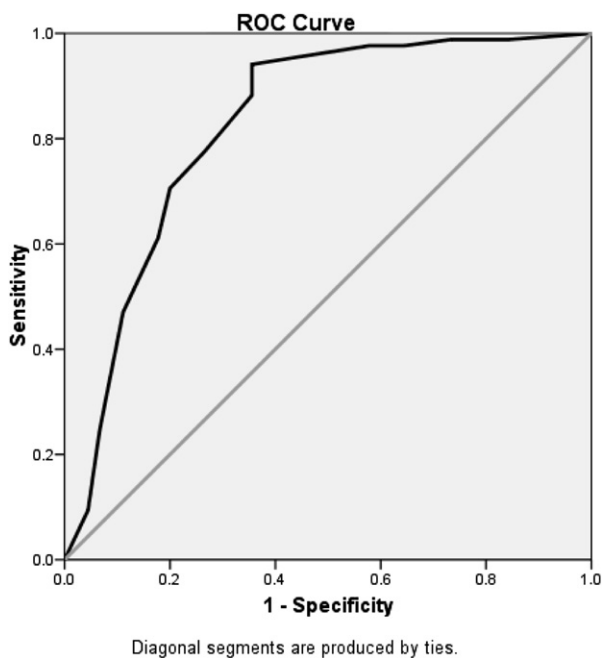
The area under the curve is 0.826 ($P < 0.001$), and the cutoff point was set at five (5) symptoms, with sensitivity of 0.94 and specificity of 0.664. Therefore, individuals with score 5 or higher (five or more symptoms) were considered at risk of having a voice disorder. With this cutoff point, the positive predictive value of the index was 72.5% and the negative predictive value was 90%.

External validation

There were 122 teachers in sample B, with an average age of 39.4 years. Of these, very few subjects reported smoking (9; 7.4%). Most of the participants teach in elementary school classrooms (74; 60.7%) and work over 31 hours a week (54; 50.8%). Most teachers in sample B have been working in this field for 11 or more years (90; 73.7.9%). The mean number of symptoms reported by the subjects in this sample was 7.2 (SD = 3.3).

In the medical examination of vocal folds, typical findings in this sample were vocal nodules, incomplete glottal closure, edema, and signs of gastroesophageal reflux on the vocal folds.

Cronbach alpha coefficient for this sample's SIVD was $\alpha = .89$. The sensitivity for the established cutoff point of five symptoms was 0.92 and the specificity was 0.39.

Figure 2 shows the comparison between the scores of samples A and B, where the distribution of reported symptoms is similar in both groups.

Figure 3 shows the means and respective 95% CIs of the final SIVD score and demonstrates that the subjects WVD had a greater mean score than those WOVD.

Of the participants WOVD, 76% scored in between 0 and 4, whereas 69% of the teachers WVD obtained higher scores, ranging in between 5 and 12. Table 1 shows a significant association between having and not having a voice disorder diagnosed by a multidisciplinary team of professionals, and the

FIGURE 1. ROC curve of the SIVD for sample A.
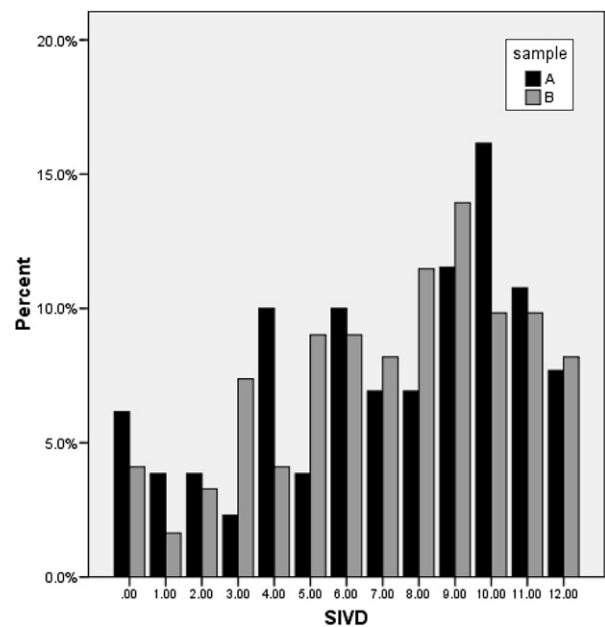
FIGURE 2. Distribution of SIVD scores for sample A and sample B.
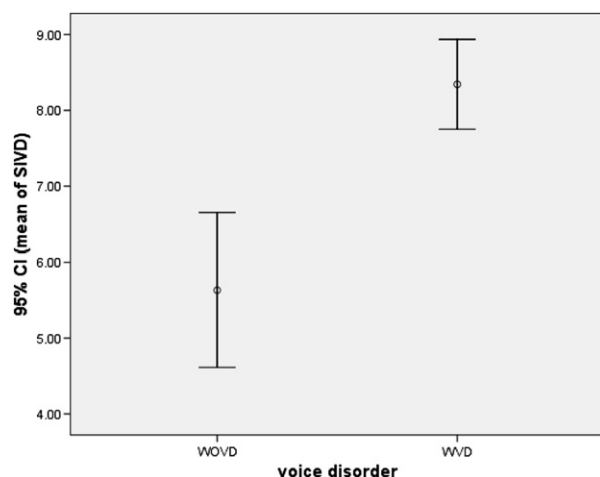
FIGURE 3. SIVD means for subjects WOVD and WVD.

subjects at risk of having a voice disorder, according to the SIVD ($P < 0.001$).

Table 2 shows a significant association ($P < 0.001$) observed between the risk of having a voice disorder and the grade of voice quality deviation (G) according to the perceptive-auditory assessment that used the GRBASI scale ($P < 0.001$).

There was a statistically significant correlation in between the final SIVD score and the total VHI score (%) ($r = 0.75$; $P < 0.001$), Emotional subscale (E) (%) ($r = 0.68$; $P < 0.001$), Functional Subscale (F) (%) ($r = 0.70$; $P < 0.001$), and Physical subscale (P) (%) ($r = 0.72$; $P < 0.001$). The correlation between SIVD and VHI in its overall and subscale scores is considered good, with a high level of statistical significance. The overall score of VHI presented the highest levels of correlation with the SIVD score.

DISCUSSION

This purpose of study was to develop and validate a score that can serve as a screening index for voice disorders in teachers. Most reliable self-reported questionnaires about voice that are currently used in vocal assessment focus primarily on issues related to quality of life and the impact of vocal disorders in everyday life, work, or emotional states.[5–7,12] The Voice Symptom Scale[8] represents a step forward in self-reported questionnaires when proposing an index that aims to contribute

TABLE 1.
Association Between the Presence of Voice Disorder and SIVD Score

	Subjects		
	WOVD	WVD	Total
SIVD	n (%)	n (%)	n (%)
0–4	19 (76)	6 (24)	25 (100)
5–12	30 (31)	67 (69)	97 (100)
Total	49 (40.2)	73 (59.8)	122 (100)

$P < 0.001$.

TABLE 2.
Association Between Grade (G) of Vocal Quality Deviation and Total SIVD Score

	GRBASI Scale (G)				
	0	1	2	3	Total
SIVD	n (%)	n (%)	n (%)	n (%)	n (%)
0–4	12 (48)	7 (28)	4 (16)	2 (8)	25 (100)
5–12	11 (11.3)	19 (19.6)	56 (57.7)	11 (11.3)	97 (100)
Total	23 (18.9)	26 (21.3)	60 (49.2)	13 (10.7)	122 (100)

$P < 0.001$.

as an inventory of vocal symptoms that may be used as a tool for assessing baseline pathologies as well as the response to change in dysphonia for adults, in clinical settings.[8]

However, there is a need for instruments of epidemiologic vigilance in voice that, when used as a tool in screening, may help to identify individuals who may have voice disorders, to contribute to large-scale studies, and to map the specific voice conditions of teachers in different moments of their careers and in different areas at one given time, whereas others are efficient mostly when assessing specific issues that are part of a disorder that is already installed. The SIVD is a tool devised for everyone, including those who do not seek professional help with voice complaints but who are likely to develop a complaint throughout their careers, for example, teachers in school. If the instrument is filled in periodically, it may ensure that teachers with initial disorders are referred for diagnosis before these become worse and significantly impact their work performance. Referral can be made either to a speech-language pathologist or otorhinolaryngologist, as long as the teachers are referred for professional assessment. The gold standard adopted in this article seeks to establish the clearest possible distinction between having and not having a voice disorder, which meant, in this case, a combination of both forms of evaluation.

Most of the teachers in this study do not report smoking, a finding that is similar to those of other studies, which investigate health habits in this population.[13–15] The occupational characteristics, such as number of working hours per week, time in the occupation, and working mostly in one school, are also similar to those found in other studies focusing on teachers.[15–17]

The developed score is named Screening Index for Voice Disorder and contains only one domain, as opposed to the findings in a similar study[4] in which two different domains were established from a similar factorial analysis. This last study selected a few factors that were not contemplated in the present study, such as restriction or loss of singing range, difficulties in projection, and constant bitter taste,[4] as opposed to other laryngeal occurrences selected in this investigation such as the presence of cough, for example.

However, the selected factors, or symptoms, are similar in both studies. Hoarseness, voice loss, breaking voice, and low-pitched voice are vocal symptoms, *per se*. These may be referred by teachers with intense vocal use, as the workload of

the subjects in this study is characterized by more than 30 hours of teaching every week. These symptoms may also be associated to environmental and work organizational factors (such as the presence of dust in the school, noise in and outside the classroom, chalk powder among others) that are also related to the occurrence of voice disorders, according to the self-reported questionnaires completed by teachers.[10,13,17]

Other symptoms: pain when speaking, pain when swallowing, dry throat, and strain when speaking are among those also observed by Roy et al[4] as laryngeal-pharyngeal sensations that are directly related to vocal use. Pain (when speaking or swallowing) may be caused by excessive vocal use in high intensity, according to teachers' reports,[15] whereas dry throat and strain when speaking may be associated to a lack of coordination between breath and speech, mainly among those teachers who already present a deviation in vocal quality.

A third group of symptoms is possibly related to allergic conditions and also to the occurrence of laryngeal-pharyngeal reflux. Phlegm, dry or wet cough, pain when swallowing, constant complaints of airway secretion, and dry throat are commonly reported symptoms in this professional category.[13,17] Moreover, the common lifestyle in this population is characterized by diverse levels of stress and irregular eating habits, such as the impossibility of keeping a regular eating schedule, and also by reduced intervals between dinner and bedtime.[15] These factors predispose the individual to the occurrence of reflux and may be reflected in symptoms such as phlegm, cough, and pain on swallowing.

The SIVD is calculated by the sum of symptoms occurring almost always and always and varies in between 0 and 12. It is important to note that there was no weight adopted for different symptoms, and each one is worth one (1) point on the final score.

The cutoff point indicative of risk for voice disorder that was established at 5 points had showed levels of sensitivity in both samples. More than half (53.8%) of the subjects in sample A scored 5 or higher. This finding points in the same direction as literature reports that estimate the prevalence of voice disorders in teachers in values close to 60%.[1–3] The number of subjects in sample B who scored 5 or higher was even closer to this estimated prevalence (58.2%).

The fact that the SIVD proved to have over 90% of sensitivity, as well as the fact that it is a short and easy to complete instrument, makes this an excellent tool for screening in teachers, as it is able to identify a great part of individuals who may have voice disorder and ensure that they are promptly referred to specific diagnosis and treatment. It is acknowledged that the specificity value for the instrument at the 5-point cutoff is quite low (39%). However, a higher cutoff point would result in a much lower level of sensitivity. Because the purpose of this instrument is to provide a useful screening tool, a choice has been made to privilege the high sensitivity, assuring that the smallest possible number of teachers with a voice disorder scores below the cutoff when taking this test. If they score 5 or more points, teachers should be referred to perceptive-auditory and ear, nose, and throat evaluations, each with increasing levels of specificity for diagnosis.

The SIVD scores proved to have good correlation with the VHI score in the studied sample. This confirms that SIVD has similar results as VHI when discriminating individuals WVD and WOVD. However, both instruments are different in their approach of voice disorders because VHI focuses on the individual's perception of the impact of the disorder, whereas SIVD takes the occurrence of actual symptoms into account. They may, therefore, complement each other as measures because, many times, the individual's complaint involves medical symptoms, not contemplated in VHI. This may be useful for researchers and clinicians, depending on the purpose of the screening they intend to perform.

This measure may be used as a tool for epidemiologic vigilance, as it screens teachers for possible voice disorders. The use of this instrument may provide better knowledge about the vocal conditions of teachers in different areas and what symptoms they most typically present. This information will be useful in devising dysphonia prevention programs, as well as in generating concrete data to make sure that specific public policies regarding occupational voice disorders in teachers are devised and reinforced. Moreover, as a simple, cheap, and time-saving tool, it may be used to discriminate individuals who are likely to have a voice disorder and will therefore serve different screening purposes depending on the context in which it is administered.

A limitation of this study consists in the fact that it was conducted only with female teachers. In Brazil, over 90% of elementary school teachers are female. This is the main reason why only females were included in the study. It is a belief that the selected group of symptoms would have remained the same if male subjects had been included, but this hypothesis can only be confirmed in future studies. Although it is recognized that in most settings, there is a higher prevalence of voice disorders in this population, we suggest that further studies undertake the same procedures and test the outcome of this measure in male teachers. We also suggest that further studies be conducted with subjects in other professional categories, children, and individuals who are not voice professionals, to compare results and expand the use of SIVD.

CONCLUSION

The SIVD is an efficient score for screening teachers for voice disorder. It is an instrument with high levels of sensitivity that may be easily and quickly completed, is reliable for use in screening, and yields results that may contribute in planning epidemiologic vigilance actions. The results of these actions may also provide subsidies for devising specific policies in public health related to occupational voice disorders.

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APPENDIX

The Screening Index for Voice Disorder (SIVD)

Please mark an "X" on the column that best expresses how frequently you experience the following symptoms:

Symptom	Never	Sometimes	Almost Always	Always
Hoarseness				
Voice loss				
Breaking voice				
Low-pitched voice				
Phlegm				
Dry cough				
Cough with secretion				
Pain when speaking				
Pain when swallowing				
Secretion/phlegm in throat				
Dry throat				
Strained speech				
Total SIVD				

Allow one (1) point for each X marked in the "almost always" and "always" columns. No points should be awarded for answers marked "never" and "sometimes". The total score is obtained by adding the number of Xs in both the almost always and always columns. If you have scored 5 or more points in total, it is strongly suggested that you consult with a voice specialist to fully assess your vocal complaints.