

Anna Carolina Ferreira Marinho¹ 
 Adriane Mesquita de Medeiros¹ 
 Eduardo de Paula Lima¹ 
 Júlia Janssen Pantuza¹ 
 Letícia Caldas Teixeira¹ 

Prevalence and factors associated with fear of public speaking

Prevalência e fatores associados ao medo de falar público

Keywords

Voice
 Speech-language Therapy
 Nonverbal Communication
 Fear
 Student

Descritores

Voz
 Fonoaudiologia
 Comunicação Não Verbal
 Medo
 Estudante

ABSTRACT

Purpose: To identify the prevalence of fear of public speaking and verify its association with sociodemographic variables, self-perception of voice, speech, and oral communication skills in public. **Methods:** A cross-sectional and analytical study with 1,124 university students was carried out. An online questionnaire addressed was performed, considering factors as sociodemographic characteristics; fear of speaking; Scale for Self-Assessment When Speaking in Public (SSPS), self-perception of the voice, the ability to grasp, and keep the listener's attention and influence another. **Results:** The fear of public speaking was prevalent in undergraduate students. There was an association of the fear of speaking with the vocal self-perception, with the ability to capture and keep the listener's attention and to influence another with their communication. Individuals who have the ability to capture and maintain the attention of the interlocutor are more likely to be afraid of public speaking than the undergraduate students who perceive themselves as having the ability to influence the listener with their communication. **Conclusion:** The more communicative skills and more persuasive the individual perceives his or her self, the less likely he or she is to be affected by the fear of speaking.

RESUMO

Objetivo: Identificar a prevalência do medo de falar em público e verificar sua associação com as variáveis sociodemográficas, autopercepção da voz, fala e habilidades de comunicação oral em público. **Método:** Estudo transversal analítico com 1124 universitários. Um questionário *online* abordou características sociodemográficas, medo de falar, autoavaliação da fala em público por meio da Escala para Autoavaliação ao Falar em Público (SSPS), autopercepção da voz, da capacidade de captar e manter a atenção do ouvinte e de influenciar o outro. **Resultados:** O medo de falar em público foi muito prevalente nos universitários. Houve associação do medo de falar com a autopercepção vocal, com a capacidade de captar e manter a atenção do ouvinte e influenciar o outro com a sua comunicação. Indivíduos que autorrelataram capacidade de captar e manter a atenção do interlocutor apresentaram maior chance de manifestar medo de falar em público em relação aos universitários que se autoperceberam como capazes de influenciar o ouvinte com a sua comunicação. **Conclusão:** Quanto mais habilidades comunicativas e mais persuasivo o indivíduo se percebe, menores as chances de ele ser acometido pelo medo de falar em público.

Correspondence address:

Anna Carolina Ferreira Marinho
 Av. Professor Alfredo Balena, 190, sala 251, Santa Efigênia, Belo Horizonte (MG), Brasil, CEP: 30130-100.
 E-mail: anna.marinho9@gmail.com, lcaldas4@gmail.com

Received: November 05, 2018.

Accepted: March 06, 2019.

Study conducted at Programa de Pós-graduação em Ciências Fonoaudiológicas, Universidade Federal de Minas Gerais – UFMG - Belo Horizonte (MG), Brasil.

¹ Universidade Federal de Minas Gerais, Belo Horizonte (MG), Brasil.

Financial support: nothing to declare.

Conflict of interests: nothing to declare.



This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Higher education demands responsibility, exceptional performance, good interpersonal relationships, and new skills and competencies⁽¹⁾ from university students. These skills and competencies include the ability to speak in public, which is constantly solicited during presentations of works, seminars, or scientific events⁽²⁾. Presentations such as those previously mentioned are often accompanied by fear⁽¹⁾.

The fear of public speaking is prevalent in the world population⁽²⁻⁵⁾ as well as at universities⁽⁵⁻⁷⁾. Among university students, fear is associated with negative self-perception of the voice, little participation in oral communication activities⁽⁶⁾, and avoidant and negative coping strategies when speaking in public⁽⁷⁾. It is a psychosocial stressor, related to characteristics of social anxiety disorder that may be generalized or performance⁽¹⁾. It is manifested by somatic symptoms, behavioral responses, and cognitive aspects^(8,9).

Somatic symptoms provoke physiological changes, behavioral manifestations triggered by the autonomic nervous system, as a defense mechanism in public speaking situations^(5,8). These symptoms include tachycardia, facial flushing, tremors, sweating, and deviations in non-verbal communication⁽⁸⁾. Studies show that, among undergrad students, there is a lot of emotional and physical discomfort before and/or during public speaking situations, and that fear of speaking⁽¹⁰⁾ causes lack of concentration, fear, tremors, and other symptoms that emotionally and cognitively harm students^(1,11,12).

Behavioral responses are characterized by the way the individual faces public speaking situations, that is, the strategies he or she uses to solve the situation^(5,11). The behavioral pattern of people who are afraid to speak in public is characterized by the of coping strategies they use to avoid the interactions or social situations in which they need to be exposed, linked to the self-perception of danger that requires protection^(1,7,11). Since public speaking situations are perceived by this population as a threat, they form negative evaluations of themselves^(1,8).

Cognitive aspects are related to the subject's beliefs about his or her public speaking, which is his or her positive or negative thoughts, in the face of these situations^(1,11,12). It is possible to observe that individuals who are afraid to speak in public tend to be more critical of themselves and present negative self-perceptions^(8,12,13). A survey of college students has shown that most students who are afraid to speak in public perceive their own voice negatively, viewing it as acute or weak⁽⁶⁾.

We hypothesize that somatic symptoms, behavioral responses, and cognitive aspects of the fear of public speaking are associated. However, the studies that approach the theme are few and do not deepen these relationships⁽⁸⁾. We believe that investigating the factors associated with somatic symptoms of fear of speaking will deepen the knowledge on the subject and will assist in the construction of communicative training and speech therapy consultancies for this purpose.

Considering the above, the objectives of this study were to identify the prevalence of fear of public speaking, operationalized in the present article as the presence of 3 or more somatic symptoms

of anxiety, and verify its association with sociodemographic variables, self-perception of voice, speech, ability to capture and keep the attention of the listener, and the influence on another through communication.

METHODS

An analytical study of a cross-sectional design approved by the Research Ethics Committee (CEP), opinion: 1,619,724. A total of 1124 university students enrolled in a Brazilian higher education institution participated in the study. 37.4% of university students were enrolled in the human sciences, 33.4% in the health area, 24.7% in the area of exact sciences and 4.5% in the arts. The mean age of the group was 25.2 years (SD = 7.8), predominating participants with up to 25 years of age (43.1%).

A questionnaire, a self-administered instrument developed by the researchers, was used for this purpose. The questionnaire was divided into four blocks.

The first block addressed questions related to sociodemographic characteristics: age, sex, reference on whether or not the stuttered, undergraduate university course, and course concentration area.

In the second block there were questions used to define the outcome (fear of public speaking). The following somatic anxiety symptoms were assessed: tremors, facial flushing, wheezing, and tachycardia. Participants should note which of these symptoms occurred during speech in public. Facing the somatic symptoms presented, the researchers were able to establish the outcome of the presence of three or more somatic symptoms of anxiety, as pointed out by the participants⁽⁸⁾.

The third block of the questionnaire consisted of the "Self-Assessment Scale for Speaking in Public-SSPS"⁽³⁾, a self-administered instrument that assesses the self-perception of speech in public, which observed the cognitive dimension of the fear of speaking in public. The SSPS scale assumes that social anxiety is the result of a negative perception of self and others in relation to self. It is composed of ten questions and two subscales, one of positive self-assessment (items 1, 3, 5, 6 and 9) and one of negative self-evaluation (items 2, 4, 7, 8 and 10), answered on a Likert scale from zero points (totally disagree) to five points (totally agree). The total score is obtained by summing the ten items of the protocol. The negative subscale score should be inverted⁽¹⁴⁾. The minimum score was 0 points to the maximum score of 50 points. In the present study, the median, with a score of 32 points, was used as a cutoff point to identify positive or negative self-assessment of speech in public. The students who scored below the median were classified as having a negative self-assessment, and those who scored at or above 32 points, were classified as having a positive self-assessment when speaking in public.

The fourth block addressed questions related to three aspects of self-assessment of oral communication that included: vocal self-perception (very bad/ bad/ good / very good), self-perception of the ability to capture and keep the listener's attention when speaking in public, (never / almost never/always / frequently), and the ability to influence others with communication (never / almost never, always / frequently). The response options

were dichotomized into “no” and “yes” responses. The response “no” was used for the answers “never” and “almost never”. The response “yes” was used for the answers “sometimes”, “almost always” and “always”.

The questionnaire and informed consent were sent online only once to students using SurveyMonkey software. Data collection lasted two months. The inclusion criteria were: to be a undergrad student, of any ethnicity, gender, or age, enrolled in a higher education institution. Those who reported a stutter and students of Speech-Language Pathology and Psychology courses were excluded from the study. A pilot study was applied previously in ten individuals to observe the understanding of the instrument. All questions were considered applicable, since the volunteers did not present difficulties in answering the questionnaire and the filling time ranged from 5 to 10 minutes.

Data analysis

The information obtained in the data collection was allocated into a digital database to be analyzed at a later time. The variable response was the fear of public speaking and the explanatory variables were: gender, age, public self-assessment (SSPS), self-perception, ability to influence others with communication, and ability to capture and keep the listener’s attention when speaking in public.

A descriptive analysis of the studied variables was performed. The analysis of factors associated with the fear of public speaking with the other variables was performed using Pearson’s Chi-Square test. The variables associated with the outcome with p value less than or equal to 0.20 were included in the multivariate model using the logistic regression (Forward Method). In this analysis, the magnitude of association of each variable, independently, with the response variable was measured by the Odds Ratio. In the final model, only those variables that remained significantly associated to the outcome were maintained. The statistical programs Statistical Package for the Social Sciences (SPSS) version 20 and STATA, version 12.0, Intercooled, Stata Corporation, Texas, United States were used.

RESULTS

Table 1 shows a sample composed of a majority of female students (64.6%), mostly concentrated in the 17-25 age group (69.5%). Somatic symptoms are present among university students, with the most frequent being wheezing (95.6%) and tachycardia (64.7%). The fear of public speaking, that is, the presence of 3 or more somatic symptoms of anxiety, was reported by 59.7% of the students. Most of the participants had a positive speech self-assessment (53.0%), poor vocal self-perception (55.2%), believe that they cannot influence the listener when speaking in public (53.0%) and cannot keep the listener’s attention (57.6%).

Table 2 shows the association between fear of public speaking and the variables: sex, age, public self-assessment of speech, and self-perception of oral communication. There was an association between the fear of speaking in public and vocal

self-perception, the capacity to capture and keep the listener’s attention, and the ability to influence the listener with his or her communication. Fear did not differ in relation to sex, age, and self-assessment of speech in public.

In the final multivariate model (Table 3) it was verified that the variables- self-perception, the capacity to capture and keep the attention of the interlocutor, and the ability to influence the listener- were maintained with statistical significance. Individuals who have the ability to capture and maintain the interlocutor’s attention during public presentations are more likely to report fear of public speaking. Those who perceive themselves as able to influence the listener with their communication skills, are less likely to be afraid of speaking in public.

Table 1. Sociodemographic characteristics, somatic symptoms of speech anxiety in public, fear of public speaking, self-assessment of speech and oral communication in public (n=1124)

Variables		N	%
Sex			
Female		726	64.6
Male		398	35.4
Age Group			
17-20 years		297	26.4
21-25 years		484	43.1
26-30 years		180	16.0
30-63 years		163	14.5
Symptoms when speaking in public			
Tremor of hands	No	452	40.2
	Yes	672	59.8
Facial flushing	No	542	48.2
	Yes	582	51.8
Wheezing	No	49	4.40
	Yes	1075	95.6
Tachycardia	No	397	35.3
	Yes	727	64.7
Fear of speaking in public (>3 symptoms)	No	453	40.3
	Yes	671	59.7
Self-assessment when speaking (SSPS)	Negative	528	47.0
	Positive	596	53.0
Self-evaluation of communication in public			
Vocal self-perception	Very bad/bad	620	55.2
	Good/very good	504	44.8
Captures and maintains attention	Never/almost never	647	57.6
	Always/ frequently	477	42.4
Influence the listener	Never/almost never	596	53.0
	Always/ frequently	528	47.0

N: number of cases; %: frequency

Table 2. Association of fear of public speaking with sex, age, self-evaluation of speech and oral communication in public (n = 1124)

		Symptoms of Fear of Public Speaking				
		No	(%)	Yes	(%)	p-value
Sex	Female	291	(64.2)	435	(64.8)	0.839
	Male	162	(35.8)	236	(35.2)	
Age Group	17-20 years	111	(24.5)	186	(27.7)	0.447
	21-25 years	199	(43.9)	285	(42.5)	
	26-30 years	80	(17.7)	100	(14.9)	
	31-63 years	63	(13.9)	100	(14.9)	
Self-assessment when speaking (SSPS)	Negative	225	(49.7)	303	(45.2)	0.137
	Positive	228	(50.3)	368	(54.8)	
Oral Communication Self-Assessment						
Vocal self-perception	Very bad/bad	268	(59.2)	352	(52.5)	0.027*
	Good/very good	185	(40.8)	319	(47.5)	
Captures and maintains Attention	Never/almost never	281	(62.0)	366	(54.5)	0.013*
	Always// frequently	172	(38.0)	305	(45.5)	
Influence the listener	Never/almost never	79	(17.4)	517	(77.0)	<0.001*
	Always// frequently	374	(82.6)	154	(23.0)	

*p-value ≤ 0.05; Pearson's chi-squared test

Table 3. Multivariate analysis of the association between fear of public speaking symptoms and the variables: ability to capture and maintain attention of the interlocutor and ability to influence the listener

Symptoms of Fear of Public Speaking		
Variable	OR*	IC (95%)**
Captures and maintains attention		
never/almost never		1.0
always// frequently	1.37	1.02-1.86
Influence the listener		
never/almost never		1.0
always// frequently	0.06	0.46-0.85

Regression Logistics * Odds ratio; ** 95% confidence interval

DISCUSSION

The results of this study indicate a high prevalence of the fear of public speaking in university students. The outcome is associated with the self-perception of not being able to influence the interlocutor with his speech and with the ability to capture and keep the listener's attention.

During public speaking, under the effect of stress, there is a release of substances in the human body that trigger body and vocal changes. Some of these substances include the hormone cortisol and neurotransmitters such as noradrenaline^(10,15). The literature describes that, commonly speaking, people may experience reactions such as tremors, sweating in the palms of the hands, tachycardia, flushing, memory defects^(10,15,16) and an irregular respiratory pattern⁽¹⁰⁾. These symptoms, in addition to generating discomfort to the speaker, can generate a negative perception of the communicator by the listener^(16,17).

Among college students, the prevalence of somatic symptoms of fear of public speaking did not statistically differentiate groups regarding sex or age. Such a result is consistent; research indicates that the fear of public speaking occurs independently of sex, ethnicity, and age⁽⁷⁾.

In the results of our study, we observed that expressing fear of speaking in public did not depend directly on a positive

or negative self-assessment when speaking in public (SSPS). Authors often argue that good communicators may not be able to get rid of the fear of speaking altogether, since the basis of fear is physiological and multifactorial^(17,18). This data is relevant so that communicative assessments value coping strategies to minimize fear including strategies for self-knowledge^(14,19-21), organization and domain of speech, public speaking experiences⁽¹⁴⁾, or therapeutic techniques utilizing breathing exercises and the voice^(10,16,20).

Most college students who are afraid of public speaking perceive their own negatively. This data did not remain statistically significant in the multivariate model. However, we encourage the use of universal vocal techniques to be incorporated into all oral communication work in public, since the voice is an instrument of communication and emotion⁽²¹⁻²³⁾ which exerts a direct influence on the hearer⁽²²⁾, it is an important factor for winning an audience and increasing self-confidence⁽²¹⁾.

The results of the multivariate analysis showed that college students who feel that they capture and maintain the attention of the listener are more likely to report fear of public speaking. However, individuals who self-reported being able to influence the listener with their communication were less likely to feel fear. Public speaking involves three fundamental goals: to inform, entertain, and persuade⁽²⁴⁾. While informing, the speaker exposes a subject and elucidates his or her ideas, but the speaker also needs to capture and maintain the attention of the listener, an ability that can be performed by entertaining the interlocutor. A speaker may do this by presenting an interesting account of a case or by telling a story, for example. However, even after overcoming these two goals, the speaker must also persuade the listener in order to influence him or her using communication⁽²⁴⁾.

Therefore, our hypothesis is that people who can influence others with communication have already developed a more refined communicative ability. They are people who have great communicative domain and expose ideas in a clear, persuasive way. They engage people in various ways and are able to

influence them. When the subject is already able to influence, or persuade, he or she is probably not excluded from fear, but is much less likely to be dominated by it.

Studies show that the accumulation of positive experiences in public speaking promotes and improves oral communication^(10,19). In this area, communicative counseling offers training and improvement for oral communication^(19,20,23,25,26). The work mobilizes positive attitudes of the communicator, increases the self-confidence of the speaker, and improves expressiveness^(19,23,25,27), which consequently reduces the anxiety of speaking in public.

How to limit the study, the cross-sectional design also does not allow analyzing the causality relationship between the studied variables. Therefore, further studies that follow the subjects longitudinally are necessary for the theme to be further explored. Also, we encourage future studies to contemplate objective and multidimensional analyses, taking into consideration self-perception of the subject, analysis of filming, and specialists in public speaking. However, we believe that the results found here contribute to progress in the construction of communicative advice based on scientific evidence, benefiting as people who need to speaking in public.

CONCLUSION

The fear of public speaking is prevalent in most undergrad students, even in individuals who believe they can capture and maintain the listener's attention, but this fear is less likely to exist in individuals who are able to influence the listener with the communication.

REFERENCES

1. Pereira SM, Lourenço LM. O estudo bibliométrico do transtorno de ansiedade social em universitários. *Arquivos Brasileiros de Psicologia*. 2012;64(1):47-63.
2. Azevedo RAS, Fernandes ACN, Ferreira LP. Oficina de expressividade para universitários em situação de apresentação de seminários. *Distúrb Comun*. 2013;25(3):458-76.
3. Osório FI, Crippa JA, Loureiro SR. Escala para auto avaliação ao falar em público (SSPS): Adaptação transcultural e consistência interna da versão brasileira. *Rev Psiquiatr Clín*. 2008;35(6):207-211. <http://dx.doi.org/10.1590/S0101-60832008000600001>.
4. Furukawa TA, Watanabe N, Kinoshita Y, Kinoshita K, Sasaki T, Nishida A, et al. Public speaking fears and their correlates among 17,615 Japanese adolescents. *Asia-Pac Psychiatry*. 2014;6(1):99-104. <http://dx.doi.org/10.1111/j.1758-5872.2012.00184.x>. PMID:23857766.
5. D'El Rey GJF, Pacini CA. Medo de falar em público em uma amostra da população: prevalência, impacto no funcionamento pessoal e tratamento. *Psicol, Teor Pesqui*. 2005;21(2):237-42. <http://dx.doi.org/10.1590/S0102-37722005000200014>.
6. Ferreira Marinho AC, Mesquita de Medeiros A, Côrtes Gama AC, Caldas Teixeira L. Fear of public speaking: perception of college students and correlates. *J Voice*. 2016;31(1):127-11. <http://dx.doi.org/10.1016/j.jvoice.2015.12.012>. PMID:26898522.
7. Maldonado I, Reich M. Estrategias de afrontamiento y medo a hablar em público en estudiantes universitários a nível de grado. *Cienc Psicol*. 2013;7(2):165-82.
8. Associação Americana de Psiquiatria. Manual Diagnóstico e Estatístico de Transtornos Mentais – DSM-5. 5. ed. Porto Alegre: Artmed; 2013. (Tradução organizada por M. I. C. Matos).
9. Osório F, Crippa JA, Loureiro SR. Aspectos Cognitivos do falar em público: validação de uma escala de autoavaliação para universitários brasileiros. *Rev Psiquiatr Clin*. 2012;39(2):48-53. <http://dx.doi.org/10.1590/S0101-60832012000200002>.
10. Barbosa RA, Friedman S. Emoção: efeitos sobre a voz e a fala na situação em público. *Distúrb Comun*. 2007;19(3):325-36.
11. Burato KR, Crippa JAS, Loreiro SR. Artigo transtorno de ansiedade social e comportamentos de evitação e segurança: uma revisão sistemática. *Estud. Psicol*. 2009;14(2):167-74.
12. Hofmann SG, DiBartolo PM. An instrument to assess self-statements during public speaking: scale development and preliminary psychometric properties. *Behav Ther*. 2000;31(3):499-515. [http://dx.doi.org/10.1016/S0005-7894\(00\)80027-1](http://dx.doi.org/10.1016/S0005-7894(00)80027-1). PMID:16763666.
13. Angélico AP, Bauth MF, Andrade AK. Estudo Experimental do falar em público com e sem plateia em universitários. *Psico-USF*. 2018;23(2):347-59. <http://dx.doi.org/10.1590/1413-82712018230213>.
14. Pedrotti CA, Behlau M. Recursos comunicativos de executivos e profissionais em função operacional. *CoDAS*. 2017;29(3):e20150217. <http://dx.doi.org/10.1590/2317-1782/20172015217>. PMID:28538820.
15. Oliveira MA, Duarte AMM. Controle de respostas de ansiedade em universitários em situações de exposições orais. *Rev Bras Ter Comport Cogn*. 2004;6:183-200.
16. Teixeira-Silva F. Trait anxiety in Brazilian university students from Aracaju. *Rev psiquiatr Rio Gd Sul*. 2008;30(1):19-24. <http://dx.doi.org/10.1590/S0101-81082008000100007>.
17. Almeida AAF, Behlau M, Leite JR. Correlação entre ansiedade e performance comunicativa. *Rev Soc Bras Fonoaudiol*. 2011;16(4):384-9. <http://dx.doi.org/10.1590/S1516-80342011000400004>.
18. Cuddy AJC. O poder da presença. Rio de Janeiro: Ed Sextante; 2016.
19. Hancock AB, Stone MD, Brundage SB, Zeigler MT. Public speaking attitudes: does curriculum make a difference? *J Voice*. 2010;2(3):302-7. <http://dx.doi.org/10.1016/j.jvoice.2008.09.007>. PMID:19481418.
20. Santos TD, Pedrosa V, Mara Behlau M. Comparação dos atendimentos fonoaudiológicos virtual e presencial em profissionais do telejornalismo. *Rev CEFAC*. 2015;17(2):385-95. <http://dx.doi.org/10.1590/1982-0216201512814>.
21. Carney DR, Cuddy AJC, Yap AJ. Power posing: brief nonverbal displays affect neuroendocrine levels and risk tolerance. *Psychol Sci*. 2010;21(10):1363-8. <http://dx.doi.org/10.1177/0956797610383437>. PMID:20855902.
22. Bicalho AD, Behlau M, Oliveira G. Termos descritivos da própria voz. *Rev CEFAC*. 2010;12(4):543-50. <http://dx.doi.org/10.1590/S1516-18462010005000048>.
23. Borrego MCM, Behlau M. Recursos de ênfase utilizados por indivíduos com e sem treinamento de voz e fala. *Rev Soc Bras Fonoaudiol*. 2012;17(2):216-24. <http://dx.doi.org/10.1590/S1516-80342012000200019>.
24. Lucas SE. A arte de falar em público. Rio de Janeiro: LTC Editora S.A.; 2003. Chapter 1, Falando em Público; p. 1-21.
25. Neiva TMA, Gama ACC, Teixeira LC. Expressividade vocal e corporal falar bem no telejornalismo: resultados de treinamento. *Rev CEFAC*. 2016;18(2):498-507. <http://dx.doi.org/10.1590/1982-021620161829415>.
26. Santos AC, Borrego MC, Behlau M. Efeito do treinamento vocal direto e indireto em estudantes de fonoaudiologia. *CoDAS*. 2015;27(4):384-91. <http://dx.doi.org/10.1590/2317-1782/20152014232>. PMID:26398263.
27. Goberman AM, Hughes S, Haydock T. Acoustic characteristics of public speaking: anxiety and practice effects. *Speech Commun*. 2011;53(6):867-76. <http://dx.doi.org/10.1016/j.specom.2011.02.005>.

Authors contributions

ACFM participated in the conception of the study, data collection, analysis, interpretation and writing of the article; AMM participated as co-orientator, in the conception, study, analysis, interpretation of data and writing of the article. EPL participated in the analysis, interpretation of data and writing of the article. JJP participated in the data collection, interpretation of data and article writing. LCT participated as orientator, in the conception, study, analysis, interpretation of data and writing of the article.