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Analysis of the Perception of Brazilian Medical Students about Chagas Disease

Everton Rodrigues Clovis [1,†], Daniel Cesaretto Cristal [2,†], Giulia Montanari [2], João Pedro Graceti Machado [2], Yago Visinho dos Reis [2], Dayse da Silva Rocha [3] and Kaio Cesar Chaboli Alevi [1,2,3,*]

1 Laboratório de Entomologia em Saúde Pública, Departamento de Epidemiologia, Faculdade de Saúde Pública, Universidade de São Paulo, Avenida Doutor Arnaldo 715, São Paulo 01246-904, Brazil
2 Instituto de Biociências, Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), Rua Dr. Antônio Celso Wagner Zanin 250, Distrito de Rubião Júnior, Botucatu 18618-689, Brazil
3 Laboratório Nacional e Internacional de Referência em Taxonomia de Triatomíneos, Instituto Oswaldo Cruz (FIOCRUZ), Av. Brasil 4365, Pavilhão Rocha Lima, sala 505, Rio de Janeiro 21040-360, Brazil
* Correspondence: kaio.chaboli@unesp.com
† These authors contributed equally to this work.

Abstract: Considering that health professionals at Brazil had doubts about the entomoepidemiological issues of Chagas disease (CD), and that many of them highlighted not feeling totally safe for clinical care, the knowledge of 281 Brazilian medical students was evaluated through a cross-sectional, descriptive, prospective, and quantitative research. Most students demonstrated that they knew about the etiological agent of CD (*Trypanosoma cruzi*), since 279 students answered the questionnaire correctly. Furthermore, the medical students demonstrated knowledge of the main form of transmission of the parasite, as 278 students associated CD transmission with triatomines. On the other hand, approximately 25 students did not associate CD transmission with triatomine feces. Besides that, these future health professionals had difficulties in relation to the treatment of CD, as more than half of the students (176) wrongly answered that CD "is not curable" or "is curable in the chronic phase". Based on the results obtained that point out the difficulties medical students have with CD, there is a need for undergraduate medical courses to address the neglected diseases holistically because the National Curriculum Guidelines for the medical course require the training of competent health professionals capable of integrating the biological, psychological, social, and environmental dimensions.

Keywords: American trypanosomiasis; *Trypanosoma cruzi*; medical education

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1. Introduction

Chagas disease (CD), described over 110 years ago by Carlos Ribeiro Justiniano das Chagas, affects approximately 6 to 7 million people and places another 25 million at infection risk [1,2], resulting in about 30,000 new cases of infection and 14,000 deaths from Chagas complications every year [2]. This neglected disease (ND) caused by the protozoan *Trypanosoma cruzi* (Chagas, 1909) (Kinetoplastida, Trypanosomatidae) can be transmitted in several ways, including organ transplantation from infected donors, laboratory accidents, ingestion of contaminated food or liquids (açai pulp, sugarcane juice, and raw meat), congenital (vertically between mother and child), and blood transfusion [1]. However, vector transmission by triatomines is considered the main form of CD dissemination in Latin America [1].

Although most infected individuals with *T. cruzi* are asymptomatic and do not exhibit clinical symptoms, 30% to 40% of patients develop cardiac diseases and/or gastrointestinal disorders [3]. The treatment available consists of benznidazole and nifurtimox, (with benznidazole being the only pharmacotherapeutic option to treat CD in Brazil) [1,4]. Both medicines are almost 100% effective in curing the disease if given soon after infection at the onset of the acute phase (which is usually asymptomatic) [5].

There are several ways to minimize the incidence of new cases of CD, among them, vector control, the performance of specific tests to detect the presence/absence of *T. cruzi* in vectors and hosts, and investment in public policies in the area of health and education, since education is considered essential to facing this ND [6–8]. Coura and Junqueira [9] highlight the need for health promotion as well as CD control based on public policies involved in health education.

Therefore, the World Health Organization (WHO) and the Pan American Health Organization (PAHO) have included the components "Information, Education, and Communication (IEC)" as one of the main complementary action strategies for global surveillance activities [6]. The maintenance of these policies that promote health education is essential because, regardless of the way the subject is approached, it allows for the clarification of issues related to CD, including prophylactics [10], and can lead to lasting and significant results [11].

Coura and Junqueira [9] discussed issues related to CD in the Amazon state and suggested that the main means of controlling this ND should be predominantly related to the education of the population and health professionals (laboratory technicians, health agents, nurses, and doctors). Apt et al. [12] evaluated the knowledge of teams of health professionals in Chile about CD and showed a low level of information (with emphasis on clinical manifestations in newborns and on diagnostic methods). From this, the authors suggested the need for a continuous educational intervention for the acquisition of new knowledge and strategies that allow adequately assessing CD serological tests, and, above all, they emphasized that the teaching-learning process of this disease should be applied both in endemic and non-endemic countries.

Similarly, Colosio et al. [13] evaluated the knowledge and attitudes of health professionals in Brazil (doctors, nurses, nursing assistants, and community health workers) about CD and observed that a significant percentage of professionals from all categories had doubts about the entomoepidemiological issues of CD, highlighting the need to adopt efficient measures of professional training in health education, aiming to maintain the control already achieved for CD and adequately care for patients infected with *T. cruzi*. Ferreira et al. [14] evaluated the knowledge of 104 Brazilian doctors about CD and highlighted that many of them reported not feeling totally safe for clinical care, and more than 30% are unaware of the drug benznidazole. Based on the above, we evaluated the knowledge of Brazilian medical students about CD.

2. Results and Discussion

Most students demonstrated that they knew about the etiological agent of CD since 279 students answered the questionnaire correctly (Table 1). Only two academics incorrectly marked the species of *Trypanosoma* Gruby, 1843 that causes CD (Table 1): one pointed out *T. brucei* (Plimmer and Bradford, 1899) (protozoan that causes sleeping sickness) [15] and the other *T. evansi* (Steel, 1885) that causes anemia trypanosomiasis [16]. An analysis of the knowledge of 57 health professionals in the United States about CD showed that 16% did not know that CD was caused by a parasite [17].

Knowledge about the basic characteristics of the causative agent of CD is essential for adequate treatment since parasites, viruses, and bacteria require different pharmacological therapies [18]. Currently, the only drug available in Brazil used to treat chagasic patients is benznidazole [1,4]. Colosio et al. [13] carried out a study on the knowledge of health professionals in Brazil about CD and reported that approximately 70% of the 73 doctors evaluated had no knowledge of the treatment of CD with benznidazole.

In addition to knowledge about the etiological agent of CD, medical students demonstrated knowledge of the main form of transmission of the parasite, as 278 students associated CD transmission with triatomines (Table 1). However, Colosio et al. [13], when evaluating this question, reported that, in general, health professionals had lower levels of knowledge about the vectors, since 84% of 73 nurses, 65% of 147 nursing assistants, and 54% of 187 community health agents reported having knowledge about the identification

of these hematophagous insects. Furthermore, Falavigna-Guilherme et al. [19] also evaluated the knowledge of health professionals from Basic Health Units (BHUs) in Brazil and observed that they did not know how to proceed in the face of notifications made by the population about the encounter of triatomines. Based on this, Colosio et al. [13] highlighted the need for training of these professionals to better serve patients and/or the needs of BHU, because the authors indicated that to maintain control of vector transmission of CD in Brazil, the population and health professionals involved must undertake epidemiological surveillance in a committed and effective way, which presupposes the involvement of political and social spheres.

Table 1. Questions applied to medical students about Chagas disease and the answers obtained.

Questions	Correct Answers (%)
What is the etiological agent of CD?	
Trypanosoma cruzi	279 (99.3%)
Trypanosoma brucei	01 (0.35%)
Trypanosoma evansi	01 (0.35%)
Trypanosoma rangeli	00 (0%)
What is the main form of transmission of Chagas disease?	
Vectorial (by triatomine feces)	253 (90%)
Vectorial (by the bite of triatomines)	25 (8.95%)
Blood transfusion	02 (0.7%)
Organ transplantation	01 (0.35%)
Congenital	00 (0%)
Is there a cure for this neglected disease?	
No	144 (51.3%)
Yes, if treatment occurs in the acute phase	104 (37%)
Yes, if treatment occurs in the chronic phase	33 (11.7%)

On the other hand, approximately 25 students did not associate CD transmission with triatomine feces (Table 1). These academics wrongly related the transmission of *T. cruzi* with the insect bite (Table 1). There are three main factors that differentiate the vector performance of triatomines when compared to other vector insects, namely: i. the form of transmission of the etiological agent, which occurs through feces/urine (while in most other vector insects it occurs through the bite); ii. the fact that both males and females act in the transmission of CD since hematophagy is mandatory in both sexes (unlike other vector insects, in which only females are hematophagous and, consequently, have vector importance); and, finally, iii. the obligation of hematophagy in all stages of development after egg hatching, allowing the intermediate stages (nymphs) to also act in the transmission of the disease (unlike most other vector insects in which only adults are hematophagous and act in vector transmission of diseases) [8,20].

Three students did not associate vector transmission as the main form of contamination (Table 1). Two of them responded with "blood transfusion", and one of them responded with "organ transplant" (Table 1). Although these forms of contamination are valid and important, triatomines are considered by the WHO to be the main means of transmission of CD [1]. In contrast to what was observed in Brazil (where most academics associated the main form of transmission with triatomines), 70% of 54 Texas health professionals did not make this association [17]. These results may be related to the fact that CD has a higher incidence in Latin America, where vectorial transmission is predominant [1] (although 300,000 cases, being at least 70 autochthonous cases of contamination by vectorial transmission have been reported in the United States [21]).

Although medical students have shown quite satisfactory knowledge about the etiological agent of CD and the main form of transmission (both had a proportion of correct answers within the expected, with $p < 0.001$), these future health professionals had difficulties in relation to the treatment of CD, as more than half of the students (176) wrongly answered that CD "is not curable" or "is curable in the chronic phase" (Table 1), the correct

answers being much lower than expected ($p = 1$). However, it is known that to control the parasitism and cure the disease in the acute phase, benznidazole or nifurtimox should be prescribed [1] because both medicines are nearly 100% effective in curing the disease if given soon after infection at the onset of the acute phase, including the cases of congenital transmission [1].

In addition to the difficulties demonstrated in the present work, Colosio et al. [13] reported that 51% of 73 Brazilian doctors analyzed in a study had difficulty associating the symptoms of the acute phase with the clinical picture of patients with CD. These professionals had greater knowledge of the clinical picture of chronic patients (65% of them correctly correlated the symptoms in this phase). Although treatment with benznidazole in the chronic phase helps to prevent morbidity and mortality, improve the patient's prognosis, and increase patient survival (reducing the occurrence of cardiomyopathy and aiding in the stability of the clinical picture [22]), it is, in general, in the acute phase that this drug promotes the cure of chagasic patients [23]. Thus, knowledge about CD and the doctors' technical competence is essential for the correct and early diagnosis of this ND [24].

Silva et al. [25] carried out a survey about the external quality assessment in the identification of triatomines in public laboratories in the state of Pernambuco, Brazil, demonstrating the weaknesses and actions to improve vector control programs, with the main action being the continuous training of health professionals. The training about the CD should also encompass knowledge about the vectors and be directed to health agents (responsible for transmitting the first information about CD to vulnerable populations), nurses, and nurse technicians, while doctors will be responsible for the diagnosis and treatment. It is worth pointing out that health agents can contribute to the diagnosis in the acute phase through reports of encounters with infected triatomines in households.

Ferreira et al. [14] evaluated the knowledge of 104 Brazilian primary health care (PHC) doctors about CD and observed that 49% of them reported that their graduation did not offer sufficient training about the CD, resulting in the fact that only 9% felt totally safe to care for patients with CD (although almost 90% of them have experience with chronic patients and 57% with patients in the acute phase). In addition, 33% of doctors reported not knowing benznidazole, demonstrating that there is insecurity, a lack of knowledge, and a lack of training on CD among PHC medical professionals [14].

Considering that the main prophylactic measure for CD is vector control [1,2], and that approximately 1.2 million cases and 6000 deaths per year have been reported in Brazil in the last few decades [26], it is important to encourage doctors to include tests for CD in routine examinations of the population. The Ministry of Health recommends a direct parasitological examination for the diagnosis of CD in the acute phase and essentially recommends serological diagnosis (presence of IgG antibodies) in the chronic phase of the disease [27]. However, there are at least eight commercialized serological rapid diagnostic tests (RDT) for *T. cruzi* infection that are effective [28], thereby decreasing the time to treatment at the primary healthcare facility for patients who are willing to be treated [28].

3. Materials and Methods

The knowledge of 281 medical students from Brazil (students of both sexes, aged 18 to 40 years) enrolled between the sixth and eighth period and who have already attended and been approved in disciplines that address knowledge about CD [Microbiology/Parasitology (80 h), Epidemiology (80 h) and Collective Health (40 h)] was evaluated through cross-sectional, descriptive, prospective, and quantitative research. Qualitative–quantitative data on the knowledge of academics about general issues related to CD were obtained from the application of a questionnaire designed specifically for this research by the online database of Google Forms, which the link was sent to academics together with the Informed Consent Form, through online communication applications, during the second semester of 2020 and the first semester of 2021.

The general aspects addressed in the questionnaire allowed us to assess basic questions about the epidemiology of CD, as they made it possible to analyze whether the students

know the etiological agent of CD (*T. cruzi*) (Question 1) and if they associate the importance of the triatomines with the vector transmission of this ND (insects that have the habit of defecating and, once infected with *T. cruzi*, release infectious forms in the feces) (Question 2). In addition, the application of the questionnaire also allowed us to assess the general clinical knowledge of future health professionals about American trypanosomiasis, enabling us to draw an overview of knowledge of important issues such as the possibility of curing chagasic patients if the disease is identified and the treatment is carried out in the acute phase (Question 3).

The proportion of correct and wrong answers for each question was analyzed using the Binomial test. For these analyses, an expected proportion of correct answers above 80% was considered (arbitrarily defined, considering the importance of knowledge of DC for these future doctors). Correct answers were considered statistically significant when $p < 0.05$. The analyses were performed in Jasp 0.16 [29].

4. Conclusions

Ferreira et al. [14] related the difficulties in the knowledge of CD with a fragmented medical education focused only on knowledge of hospital practices. Taking into account that CD was described by a doctor who characterized all aspects of the disease, including the etiological agent, symptoms, forms of the protozoan, as well as vector insects (Triatominae subfamily) and vertebrate hosts [30], and based on the results presented here, there is a need for undergraduate medical courses to address ND holistically. It is important to mention that the National Curriculum Guidelines for the medical course require the training of competent health professionals capable of integrating the biological, psychological, social, and environmental dimensions and capable of acting for the development of the United Health System [31]. Furthermore, we emphasize the importance of a theoretical and practical approach for general physicians in the context of the strategies for the diagnosis and management of orally transmitted and congenital disease, as well as treatment of reproductive-age women, and all forms of acute disease and CD reactivation and management of chronic CD, sometimes associated with immunosuppression, with the aim of guarantee qualified health care for CD in Brazil, considering the prevalence of all forms of transmission in this country. Finally, we emphasize that although our results contribute to the direction of medical education in Brazil, the lack of questions related to the clinical diagnosis of CD is a study limitation that needs to be investigated in future studies.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: All relevant data are within the manuscript.

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References

1. World Health Organization. Chagas Disease (American Trypanosomiasis). Available online: http://www.who.int/news-room/fact-sheets/detail/chagas-disease-(american-trypanosomiasis) (accessed on 27 July 2022).
2. Pan American Health Organization. Chagas in the Americas. Available online: https://www3.paho.org/hq/index.php?option=com_content&view=article&id=13566:chagas-in-americas&Itemid=40721&lang=en (accessed on 27 July 2022).
3. Pérez-Molina, J.A.; Molina, I. Chagas disease. *Lancet* **2018**, *391*, 82–94. [CrossRef] [PubMed]
4. Correia, J.P.R.; da Costa, A.C.; Rocha, E.A.; Quidute, A.R.P.; Cândido, D.D.S.; Ponciano, Â.M.D.S.; Fonteles, M.M.D.F.; Oliveira, M.D.F. Pharmacotherapeutic follow-up of patients with Chagas disease using benznidazole: Drug-related problems and pharmaceutical interventions. *Rev. Soc. Bras. Med. Trop.* **2017**, *50*, 334–340. [CrossRef] [PubMed]
5. Pan American Health Organization. Chagas Disease. Available online: https://www.paho.org/en/topics/chagas-disease (accessed on 27 July 2022).
6. Sanmartino, M.; Mateyca, C.; Pastorino, I.C. What are we talking about when we talk about education and Chagas? A systematic review of the issue. *Biochim. Biophys. Acta (BBA) Mol. Basis Dis.* **2020**, *1866*, 165691. [CrossRef] [PubMed]
7. De Souza, B.B.O.G.A.; De Almeida, M.C.; Loula, N.M.C.; Alves, K.K.A.F.; Dos Santos, C.S.; Dourado, D.L.O.; Damasceno, V.A. A educação em saúde na atuação contra os impactos da doença de Chagas. *Res. Soc. Dev.* **2020**, *9*, e799997873. [CrossRef]
8. Clovis, E.R.; Cristal, D.C.; Montanari, G.; Alevi, K.C.C. Importância da educação formal e informal para a profilaxia de doenças negligenciadas transmitidas por vetores: O caso da doença de Chagas. In *Atualidades em Medicina Tropical na América do Sul: Vetores*; Oliveira, J., Alevi, K.C.C., Camargo, L.M.A., Meneguetti, D.U.O., Eds.; Strictu Sensu Editora: Rio Branco, Acre, Brazil, 2021; pp. 184–197.
9. Coura, J.R.; Junqueira, A.C. Surveillance, health promotion and control of Chagas disease in the Amazon Region—Medical attention in the Brazilian Amazon Region: A proposal. *Memórias Inst. Oswaldo Cruz* **2015**, *110*, 825–830. [CrossRef]
10. dos Santos, C.V.; Bianchi, T.F.; de Leon, Í.F.; Telles, L.F.; Wilhelms, T.S.; Bedin, C.; Carlan, F.D.A.; Villela, M.M. Calendário ilustrativo: Uma abordagem no combate à doença de chagas e seus vetores. *Braz. J. Dev.* **2021**, *7*, 33389–33404. [CrossRef]
11. Grimes, C.; Ronchi, D.L.; Hirano, Z.M.B. Prática pedagógica diferenciada nos processos de ensinar e de aprender em parasitologia. *Ensino Saude e Ambiente* **2013**, *6*, 89–100. [CrossRef]
12. Apt, W.; Galafé, S.; Zulantay, I.; Yuhasz, S.; Urbina, P.; Yévenes, K.; Rodríguez, J. Chagas Disease: A Global Neglected Disease that Require Continuous Medical Education. *J. Community Med. Health Educ.* **2013**, *4*, 1000260. [CrossRef]
13. Colosio, R.C.; Falavigna-Guilherme, A.L.; Gomes, M.L.; Marques, D.S.O.; Lala, E.R.P.; Araújo, S.M. Conhecimento e atitudes sobre a Doença de Chagas entre profissionais de saúde—Paraná, Brasil. *Cienc Cuid Saúde* **2007**, *6*, 355–363. [CrossRef]
14. Ferreira, A.; Sabino, E.C.; Moreira, H.F.; Cardoso, C.S.; Oliveira, C.D.L.; Ribeiro, A.L.P.; Ramos, B.D.C.; Haikal, D.S. Avaliação do conhecimento acerca do manejo clínico de portadores da doença de Chagas em região endêmica no Brasil. *Rev. APS* **2018**, *21*, 345–354. [CrossRef]
15. World Health Organization. Trypanosomiasis, Human African (Sleeping Sickness). Available online: https://www.who.int/news-room/fact-sheets/detail/trypanosomiasis-human-african-(sleeping-sickness) (accessed on 27 July 2022).
16. Silva, R.A.M.S.; Herrera, H.M.; Domingos, L.B.D.S.; Ximenes, F.A.; Dávila, A.M.R. Pathogenesis of Trypanosoma evansi infection in dogs and horses: Hematological and clinical aspects. *Ciência Rural* **1995**, *25*, 233–238. [CrossRef]
17. Granados, P.S.; Pacheco, G.J.; Patlán, E.N.; Betancourt, J.; Fulton, L. Assessing the effectiveness of Chagas disease education for healthcare providers in the United States. *BMC Infect. Dis.* **2020**, *20*, 743. [CrossRef]
18. Shen, S.-S.; Qu, X.-Y.; Zhang, W.-Z.; Li, J.; Lv, Z.-Y. Infection against infection: Parasite antagonism against parasites, viruses and bacteria. *Infect. Dis. Poverty* **2019**, *8*, 49. [CrossRef]
19. Falavigna-Guilherme, A.L.; Costa, A.L.; Batista, O.; Pavanelli, G.C.; De Araújo, S.M. Atividades educativas para o controle de triatomíneos em área de vigilância epidemiológica do Estado do Paraná, Brasil. *Cad. Saúde Pública* **2002**, *18*, 1543–1550. [CrossRef]
20. Galvão, C. *Vetores da Doença de Chagas no Brasil*; Sociedade Brasileira de Zoologia: Curitiba, Brazil, 2014.
21. Beatty, N.L.; Klotz, S.A. Autochthonous Chagas Disease in the United States: How Are People Getting Infected? *Am. J. Trop. Med. Hyg.* **2020**, *103*, 967–969. [CrossRef]
22. Viotti, R.; Vigliano, C.; Armenti, H.; Segura, E. Treatment of chronic Chagas' disease with benznidazole: Clinical and serologic evolution of patients with long-term follow-up. *Am. Heart J.* **1994**, *127*, 151–162. [CrossRef]
23. Cançado, J.R. Long term evaluation of etiological treatment of chagas disease with benznidazole. *Rev. Inst. Med. Trop. São Paulo* **2002**, *44*, 29–37. [CrossRef]
24. Araújo, S.M.; Gomes, M.L.; Ortiz, M.; Costa, A.L.; Membrive, U.A.; Toledo, M.J.O.; Guilherme, A.L.F. Doença de Chagas em crianças no Estado do Paraná, Brasil. *Rev. Bras. Anal. Clin.* **2004**, *36*, 151–153.

25. Silva, M.B.A.; Borba, R.F.B.; Ferreira, G.M.O.G.; Medeiros, C.A.; Rocha, D.S. External quality assessment of entomological identification of triatomines carried out in the Pernambuco Public Health Laboratory network, Brazil, 2017. *Epidemiol. Serviços Saúde* **2021**, *30*, e2020877. [CrossRef] [PubMed]
26. Martins-Melo, F.R.; Ramos Jr, A.N.; Alencar, C.H.; Heukelbach, J. Mortality from neglected tropical diseases in Brazil, 2000–2011. *Bull. World Health Organ.* **2016**, *94*, 103–110. [CrossRef] [PubMed]
27. Machado-de-Assis, G.F.; Silva, A.R.; do Bem, V.A.; Bahia, M.T.; Martins-Filho, O.A.; Dias, J.C.; Albajar-Viñas, P.; Torres, R.M.; de Lana, M. Posttherapeutic cure criteria in Chagas disease: Conventional serology followed by supplementary serological, parasitological and molecular tests. *Clin. Vaccine Immunol.* **2012**, *19*, 1283–1291. [CrossRef] [PubMed]
28. Sánchez-Camargo, C.L.; Albajar-Viñas, P.; Wilkins, P.P.; Nieto, J.; Leiby, D.A.; Paris, L.; Scollo, K.; Flórez, C.; Guzmán-Bracho, C.; Luquetti, A.O.; et al. Comparative Evaluation of 11 Commercialized Rapid Diagnostic Tests for Detecting Trypanosoma cruzi Antibodies in Serum Banks in Areas of Endemicity and Nonendemicity. *J. Clin. Microbiol.* **2014**, *52*, 2506–2512. [CrossRef] [PubMed]
29. JASP Team. JASP, Version 0.16.2; Computer Software; 2022. Available online: https://jasp-stats.org/ (accessed on 20 October 2022).
30. Chagas, C. Nova tripanozomiase humana. Estudos sôbre a morfologia e o ciclo evolutivo de *Schizotrypanum cruzi* n. gen., n. sp. ajente etiolójico de nova entidade mórbida do homem. *Mem. Inst. Oswaldo Cruz* **1909**, *1*, 159–218. [CrossRef]
31. BRASIL. Ministério da Educação. Conselho Nacional de Educação. Câmara de Educação Superior. Resolução n. 3, de 20 de junho de 2014. Available online: http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=15874-rces003-14&Itemid=30192 (accessed on 27 July 2022).