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Analysis of the structure of Basic Health Units in Brazil to conduct telehealth actions: a comparison of two cross-sectional studies

Denise Oliveira Franco[1], Mauro Henrique Nogueira Guimarães Abreu[2], Rafaela Silveira Pinto[2], Antônio Thomaz Gonzaga Matta-Machado[3] and Renata Castro Martins[2,4*]

Abstract

Background Telehealth uses Information and Communication Technologies (ICT) in distance health-related activities between professionals, managers, and patients of health services. This cross-sectional study compared the ICT infrastructure available in Brazilian Basic Health Units (BHU) for telehealth actions, along with evaluation cycles of the National Program for Improving Access and Quality of Primary Care (PMAQ-AB).

Methods Data from the second and third cycles of the PMAQ-AB were used. A total of 22,021 BHUs were evaluated concerning the availability of computers, cameras, stereo boxes, microphones, printers, television, and internet available. The presence of each ICT equipment assigned a score to each BHU. The sum of these scores assigned a final score to the BHU and was used for comparison among different Brazilian regions. The data were analyzed descriptively and by Wilcoxon test ($p \leq 0.05$) using SPSS v. 25.

Results The increase in the median number of ICT equipment was statistically significant in the BHU in Brazil and the Brazilian regions ($p < 0.001$). The South, Southeast, and Midwest regions had the highest median scores in both cycles.

Conclusions The availability of ICT equipment for telehealth actions in BHU improved over the PMAQ-AB cycles, with differences in the ICT structure between Brazilian regions.

Keywords Telemedicine, Primary Health Care, Information Technology

*Correspondence:
Renata Castro Martins
renatacm@ufmg.br
[1]School of Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
[2]Department of Community and Preventive Dentistry, School of Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
[3]Department of Preventive and Social Medicine, School of Medicine, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
[4]School of Dentistry, Universidade Federal de Minas Gerais - UFMG, Minas Gerais, Av. Pres. Antônio Carlos, 6627 - Pampulha, Belo Horizonte 31270-901, Brazil

Background

Telehealth is the use of Information and Communication Technologies (ICT) in distance health-related activities between professionals, managers, and patients of health services [1]. Telehealth has advantages such as reduced waiting time to access health services, better collaboration between the professionals of the multidisciplinary teams [2, 3], reduced time to diagnosis, resolution of treatments [2], and streamlined financial resources without compromising the quality of care [4]. It also helps overcome logistical-territorial barriers by enabling better working conditions and less isolation of professionals working in remote areas [1, 5]. However, barriers such as lack of technology use knowledge, ICT funding and structure, and telehealth training need to be overcome [6].

Several countries have incorporated Telehealth as a routine practice in their health services [3, 7]. In Brazil, the experience with distance health-related care and education started in 2007 with the implementation of the National Telehealth Program by the Brazilian Ministry of Health. This program aims to strengthen and improve the resolution of Primary Health Care (PHC) and increase the population's access to specialized services [8]. It has expanded and was redefined over the years. It is currently called the Telehealth Brazil Networks Program [9]. The services offered by the Telehealth Brazil Networks Program aimed at professionals, specialists, and managers in the Brazilian Unified Health System (UHS) healthcare networks include teleconsulting, web conferences, formative second opinion, telediagnosis, and tele-education [9]. The actions of this telehealth program reduce referrals to other healthcare levels and shrink waiting lists [10].

Changes were made to the regulatory framework of Brazilian professions during the COVID-19 pandemic, allowing telemonitoring and teleadvice [11]. As a result, instant messaging applications and the use of telephones facilitated the exchange of information between professionals and patients [12].

Telehealth demand is growing in Brazil [4, 12]. However, the prevalent use of this service was identified in the South and Southeast regions of the country, in municipalities with up to 30 thousand inhabitants, in Basic Health Units (BHU) with at least one doctor and a telephone in the establishment [13].

The National Program for Improving Access and Quality of Primary Care (PMAQ-AB in Portuguese) was implemented by the Brazilian Ministry of Health to expand coverage increase access and improve the quality of services and the PHC work process. The PMAQ-AB is the most prominent health services evaluation program ever devised in the country [14]. The implementation of PMAQ-AB comprised three complementary phases (adherence and contractualization; certification; and re-contractualization) and a strategic cross-cutting development axis with self-assessment, monitoring, continuing education, institutional support, and horizontal cooperation actions. The BHUs adhered to the program through commitment pacts and performance indicators. The PMAQ-AB was assessed in continuous cycles: Cycle I (2011–2012); Cycle II (2013–2014); and Cycle III (2017–2018) and aimed to overcome some challenges for qualifying PHC, such as low investment in ICT infrastructure, insufficient use of information technology for decision-making, the deficient physical structure, and the unsatisfactory conditions of the BHU [15]. The evaluation of health services allows for analyzing the quality of care, detecting and correcting failures, and providing information to improve the decision-making process regarding health practices and policies, favoring the expansion and equitable access to health services [16].

Three relevant components analyze the quality of health care: structure (static characteristics of the personnel providing care and the place where care was provided), process (how care was provided), and outcomes (measured by health status indicators). Structure influences the process, which in turn affects the outcome [17]. Good structure does not necessarily lead to good processes and outcomes, but its importance should be considered [18]. The availability of adequate infrastructure influences the delivery of effective healthcare services. The lack of it compromises care, goal achievement, and the quality of services provided [17, 19, 20].

The aim was to compare the ICT infrastructure available in the BHU along with evaluation cycles of the PMAQ-AB that facilitate the development of telehealth actions by Brazilian regions. The null hypothesis is that there was not a difference in ICT infrastructure in the BHU over the cycles of PMAQ-AB.

Methods

This cross-sectional study used secondary data from the PMAQ–AB second (https://aps.saude.gov.br/ape/pmaq/ciclo2/) and third cycles (https://aps.saude.gov.br/ape/pmaq/ciclo3/). conducted in 2013/2014 and 2017/2018, respectively. The data were obtained during the external evaluation stage of PMAQ–AB second and third cycles. An instrument, developed by the Brazilian Ministry of Health [15] in partnership with educational or research institutions was used to PMAQ–AB second (https://www.gov.br/saude/pt-br/composicao/saps/pmaq/ciclos-do-pmaq-ab/2o-ciclo/instrumentos-de-avaliacao-externa) and third cycles (https://www.gov.br/saude/pt-br/composicao/saps/pmaq/ciclos-do-pmaq-ab/3o-ciclo/instrumentos-de-avaliacao-externa). A group of trained interviewers applied a questionnaire to assess the conditions of access and quality of primary care of the municipalities participating in the program. The questionnaire was applied in the BHU to a professional responsible for the establishment and designated to answer the questions. The data collected were transferred to the Brazilian Ministry of Health's database [15].

The external evaluation was developed in six different modules. This study used data from Module I – Observation in BHUs; subdimension – Information Technology and telehealth equipment.

A total of 24,499 BHUs participated in the second cycle and 30,346 BHUs in the third cycle. Only BHUs that participated in both cycles of PMAQ-AB were included in the study. The BHU of the second and third cycles were matched by the National Registry of Health Establishments (CNES in Portuguese). The database of the first cycle of the PMAQ-AB was not used because it needed the CNES to match BHU with the other cycles.

Figure 1 shows the inclusion and exclusion criteria for BHU. A total of 452 BHU of the second cycle were excluded from this study (372 BHU without application of the questionnaire by the interviewers, 72 without information about the questionnaire application, and 8 with duplicate CNES). In the third cycle, 1,407 BHUs were excluded because the interviewers did not apply the questionnaire. A total of 24,047 BHU in the second cycle and 28,939 BHU in the third cycle database were sequentially linked using the common variable CNES. However, 2,026 BHU of the third cycle were excluded for not containing information. The final sample was 22,021 BHU in the PMAQ-AB second and third cycles.

Six numerical and one categorical question were used to evaluate the availability of ICT that enable telehealth actions. Only questions common to both cycles of PMAQ-AB and without missing data were considered. The numerical questions evaluated the number of computers, cameras, stereo boxes, microphones, printers, and television. The BHU with at least one piece of

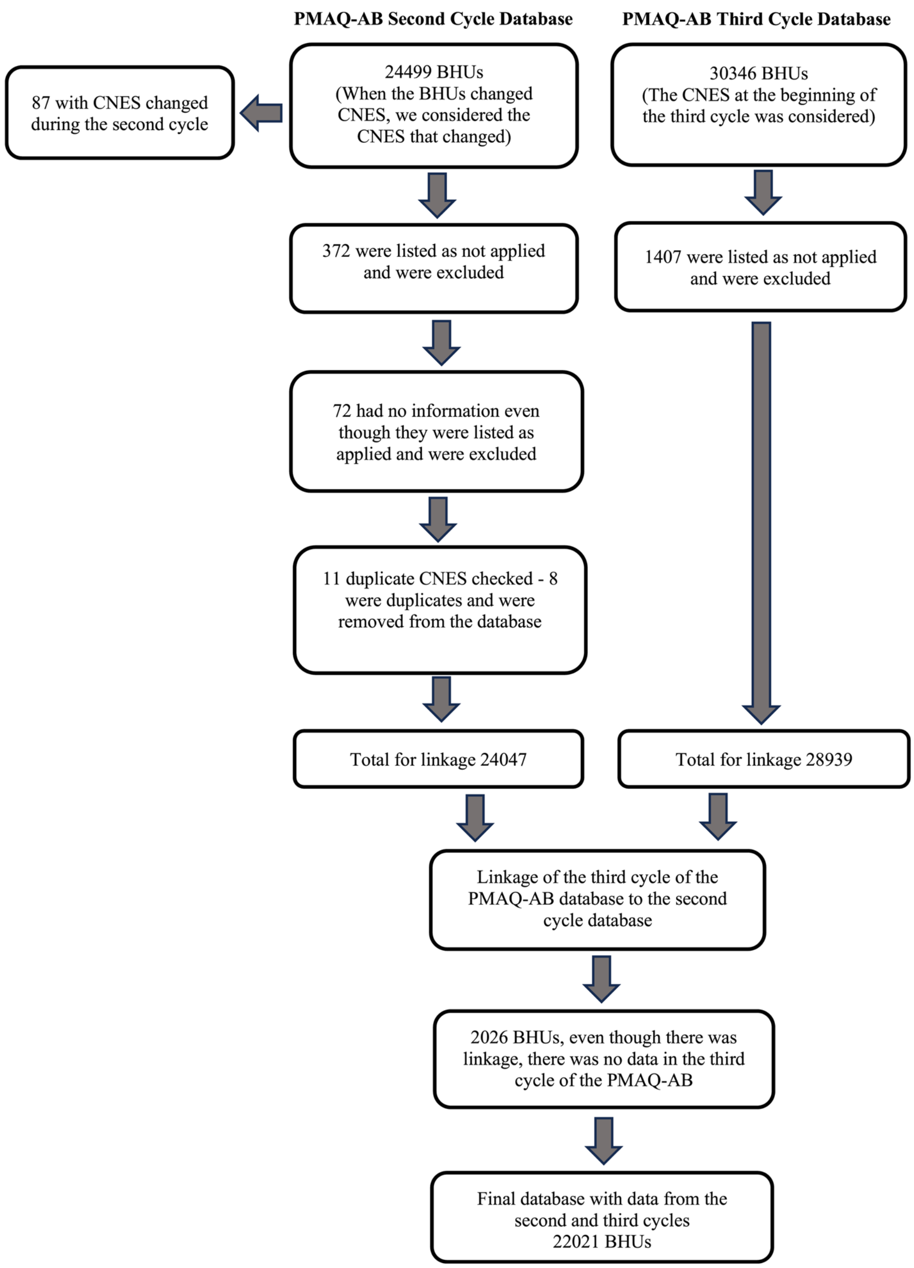

Fig. 1 The flowchart of the inclusion and exclusion criteria for BHUs for the second and third cycles of the PMAQ-AB

Table 1 Descriptive analysis of the availability of ICT at BHUs in the second and third cycles of PMAQ-AB

Variable	Cycle 2 *n* (%)	Cycle 3 *n* (%)
Computer		
No	6761 (30.7)	1874 (8.5)
Yes	15,260 (69.3)	20,147 (91.5)
Camera		
No	18,720 (85.0)	15,932 (72.3)
Yes	3301 (15.0)	6089 (27.7)
Stereo Box		
No	13,341 (60.6)	11,312 (51.4)
Yes	8680 (39.4)	10,709 (48.6)
Microphone		
No	19,727 (89.6)	18,223 (82.8)
Yes	2294 (10.4)	3798 (17.2)
Printer		
No	10,818 (49.1)	6918 (31.4)
Yes	11,203 (50.9)	15,103 (68.6)
Television		
No	9641 (43.8)	8426 (38.3)
Yes	12,380 (56.2)	13,595 (61.7)
Internet		
No	11,179 (50.8)	5151 (23.4)
Yes, insufficiently	2289 (10.4)	2276 (10.3)
Yes, sufficiently	8553 (38.8)	14,594 (66.3)

ICT equipment received a score of 1, and BHU without ICT equipment received a score of 0. The categorical question was "Is the available bandwidth/internet sufficient to carry out the activities" (Yes, sufficiently, Yes, insufficiently, No, and Not applicable). The option "Not applicable" was answered when the BHU did not have access to the internet and was considered as No. BHU received a score of 1 when they answered "Yes, sufficiently"; a score of 0.5 when they answered "Yes, insufficiently"; and a score of 0 when the answer was "No" or "Not applicable".

The availability of each ICT equipment assigned a score to each BHU, with the final score being the sum of the number of equipment identified in the health service (from 0 to 7 points). For example, if a BHU score is 5, this service has 5 of the 7 ICT for telehealth actions.

For data from both cycles, a descriptive analysis was performed using the Statistical Package for the Social Sciences v. 25.0 (IBM SPSS Statistics for Windows, Armonk, USA). The normality scores of the second and third cycles were analyzed by the Kolmogorov-Smirnov test and evidenced an asymmetric distribution ($p<0.001$). Then, the Wilcoxon test ($p\leq0.05$) was used to compare the scores of BHU in Brazil and Brazilian regions.

This study was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (CAAE −02396512.8.0000.5149).

Results

Table 1 shows an increase in the number of BHUs for all ICT equipment analyzed from the second to the third cycle of PMAQ-AB.

Table 2 shows a statistically significant median increase of ICT for telehealth actions at BHU from the second to

Table 2 Analysis of ICT scores for telehealth actions in BHUs of the second and third cycles of PMAQ-AB in Brazil and Brazilian regions

Regions	Median	Quartile 1	Quartile 3	Normality Test[a]	Difference between cycles[b]
North					
Cycle 2	2	0	3.5	< 0.001	< 0.001
Cycle 3	3	2	4	< 0.001	
Northeast					
Cycle 2	1	0	3	< 0.001	< 0.001
Cycle 3	3	2	5	< 0.001	
Southeast					
Cycle 2	4	2	5	< 0.001	< 0.001
Cycle 3	4	3	5	< 0.001	
South					
Cycle 2	4.5	3	6	< 0.001	< 0.001
Cycle 3	5	4	6	< 0.001	
Midwest					
Cycle 2	3.5	2	4.5	< 0.001	< 0.001
Cycle 3	4	3	5	< 0.001	
Brazil					
Cycle 2	3	1	4.5	< 0.001	< 0.001
Cycle 3	4	3	5	< 0.001	

[a]Kolmogorov-Smirnov

[b]Wilcoxon test

the third cycle in Brazil and Brazilian regions (<0.001). The median scores of the South (4.5;5), Midwest (3.5;4), North (2;3), and Northeast (1;3) increased from the second to the third cycle, respectively. Only the Southeast region maintained the median value of the equipment (4) in both cycles. The South, Southeast, and Midwest regions showed the highest median scores in both cycles, displaying the best ICT structures.

Discussion

The study showed significant improvement in the availability of ICT infrastructure in the BHU of Brazil that favors telehealth actions, over the cycles of PMAQ-AB, rejecting the null hypothesis. The best ICT structures in both PMAQ-AB cycles were identified in the South, Southeast, and Midwest regions, respectively, with regional differences.

The number of all ICT equipment evaluated in this study increased at the BHUs, from the second to the third PMAQ-AB cycle. Establishing monthly financial incentives for Telehealth centers of municipalities and states that use telehealth [21] and the Brazilian Health Information and Informatics Policy, established in 2015, may have favored this finding [22]. This policy encourages the process of incorporating ICT infrastructure. It encourages the use of this equipment in health care and distance education to improve the resolution of PHC in the UHS [23]. Research using data from the first and second cycles of PMAQ-AB also showed better indicators evaluating infrastructure in the BHU and the work process of the Family Health Strategy in the municipalities of Ceará, Brazil [20].

The computer was the equipment that showed the most significant increase from the second to the third cycle of PMAQ-AB in this study. More than 90% of BHUs in the third cycle had computers. Computers are necessary to realize practically all the actions developed by Telehealth. The use of this technology by physicians during teleconsultations and telediagnoses in disaster situations and remote areas contributed to the communication between the professionals involved in providing safe and effective care for the patient [1]. The availability of computers in BHU is significant for teleconsulting, and the increase of this equipment identified by this study may have contributed to the growing use of teleconsulting in recent years [12]. Improving ICT infrastructure in health services directly impacts safer, more equitable, and higher-quality telehealth programs. An innovative telehealth model, with a Donabedian approach based on structure, process, and outcome evaluation, could be used by health experts to plan high-quality telehealth programs [19].

The increase in BHUs with a camera, stereo box, and microphone was not expressive. Less than 50% of Brazilian BHU had this equipment at the end of the third cycle. The low availability of this ICT equipment in health services can compromise Telehealth, reduce the fulfillment of goals by work teams, and compromise the quality of the service provided. The non-use of Telehealth has been associated with the need for ICT equipment and training in the use of technologies [8]. Camera, stereo box, and microphone are components utilized for video calls and web conferences, modalities of Telehealth that have been growing in recent years due to the COVID-19 pandemic [11]. Studies revealed the importance of telehealth technology as a support to confront the COVID-19 pandemic [4, 11, 24] PHC had to overcome this equipment's low availability to continue their remote care to patients during the COVID-19 pandemic. This period witnessed a change in strategies for accessing health services, with the spread of Telehealth and improved incorporation of ICT in Brazilian PHC [4]. An adequate ICT infrastructure and maintaining a qualified team in a public health emergency are fundamental in reorganizing the health system [4]. The successful use of telehealth during the pandemic could increase public and government acceptance of ICT for other areas of health in the future, such as chronic diseases, strengthening Brazil's unified and universal system [25].

The availability of televisions and printers was identified in more than 60% of the evaluated establishments. The good availability of this equipment and stereo boxes in BHU may favor continuing education through tele-education. The research analyzed the advances of Telehealth as a resource for continuing education of health professionals. It showed that using ICT in distance education is effective in teaching-learning, training, and capacity building of professionals. Moreover, it is considered that tele-education can improve problem-solving development in the face of new demands [23]. Besides the incentive to incorporate ICT in the UHS already mentioned, the Brazilian Health Information and Informatics Policy also fosters the development of specific programs for training in continuing health education. These programs increased ICT in PHC because they aim to expand and qualify the production and use of health information and informatics [22].

An increase in the number of BHUs with sufficient internet during the second to the third cycle of the PMAQ was observed. The adequate availability of this resource can favor the realization of the various telehealth modalities. The study described the infrastructure of a teledermatology service, which uses the web and an associated mobile application to support PHC professionals during telehealth actions, such as telediagnosis and screening and referral of patients. The authors found a progressive improvement in the technical quality of dermatological examinations performed by professionals and the primary care level case resolution [26].

However, one-third of the BHUs evaluated in this study still needed sufficient internet or had no internet. Good communication can be difficult with poor audio-visual quality and issues of time sound lag due to insufficient internet speed. Small technical failures may not significantly hinder the provision of care, but significant technical failures decrease the quality of the service [27].

Although the availability of infrastructure has a positive impact on improving the volume and quality of health services [17, 19], a study using data from the second cycle of PMAQ-AB found discordant results when analyzing the use of the telehealth service. The authors found an association between the variables of institutional support and implementation of Telehealth in BHU with the increase in the use of Telehealth. However, concerning structural variables, such as the internet and availability of rooms for Telehealth, the impact on the use of ICT was not significant [13].

An increase in the median number of ICT equipment for telehealth actions in BHU from the second to the third cycle in Brazil and the Brazilian regions was identified. Other studies have also used PMAQ-AB data to analyze the amount of infrastructure present in BHUs for other health services offered by PHC and found positive results that directly influence the proper functioning of services and the effectiveness of care [18, 28].

The analysis by Brazilian regions showed the heterogeneity in the availability of ICT equipment in BHUs. The South and Southeast regions had the best medians, followed by the Midwest. The differences found can be explained by the influence that each region's socioeconomic and demographic conditions have on the type of organization of health services. Brazil is a developing country with a sizeable territorial extension and high socioeconomic inequality, which may justify the different types of service management in Brazilian regions [24, 29]. The country has significant internal health inequities, with a heterogeneous distribution of infrastructure and differences in the qualifications of professionals [29]. The country's economy is concentrated in the South and Southeast [29], and these regions have the most significant number of states with telehealth centers and the best structured, such as the centers of Rio Grande do Sul and Minas Gerais [30]. Other studies have also found regional differences with better results for the South and Southeast [18, 28], reinforcing the idea that health inequalities in Brazil are regional. In this context, ICT structure can be a critical element in minimizing regional inequalities in the distribution of health resources and referring specialists, facilitating second opinions for specialized or rare clinical cases, and establishing continuing education for health professionals [24, 29].

The worst medians were found in the north and northeast regions. The differences among Brazilian regions may reflect the lower socioeconomic development of these regions of Brazil, which face difficulties, especially in infrastructure and basic sanitation [31]. The effectiveness of telehealth programs depends on several factors, such as patient health determinants, policy, provider competencies, and organizational infrastructure [19], which are more deficient in these regions.

Health information systems are monitoring and data collection tools, that provide information for analysis and better understanding of important health problems in the population, supporting decision-making at the municipal, state, and federal levels. In Brazil, over the last 30 years, these recommendations have been embraced by the Ministry of Health and the Brazilian Institute of Geography and Statistics (IBGE) which have generated the possibility of information for decision-making among managers of the federal entities, based on an almost infinite amount of data produced daily in health services [32]. This study has limitations due to the use of secondary data, which may result in data loss during extraction and errors arising from data collection and processing methodology before being made available to researchers. Some information on BHU retrieved from the databases must be completed or included. However, this study is relevant because it compares the infrastructure of the BHU throughout Brazil, a country with an enormous territorial dimension, using the databases obtained by the most robust national health services evaluation program ever instituted. These results highlight that adequate infrastructure for Telehealth can contribute to democratizing the population's access to health services with safe and effective care. Although the data is pre-pandemic, it is useful for diagnosing the need for advances in information technology in PHC. During a pandemic, the ICT structures have become more used due to an exponential growth in the use of health technologies in the Brazilian Unified Health System. Further studies should be carried out to understand how ICT infrastructures expanded and were used during the pandemic in the regions of Brazil.

Conclusion

There was an improvement in the ICT infrastructure in BHU for telehealth actions throughout Brazil. However, differences in the ICT structure among Brazilian regions were observed. The South, Southeast, and Midwest regions had a better ICT structure. The worst infrastructure conditions occurred in BHU in regions with more significant social problems and precarious forms of care organization.

Abbreviations

ICT	Information and Communication Technologies
BHU	Basic Health Units
PMAQ-AB	Program for Improving Access and Quality of Primary Care
PHC	Primary Health Care

UHS Unified Health System
CNES National Registry of Health Establishments

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Authors' contributions
Conceptualization, M.H.N.G.A. and R.C.M.; methodology, M.H.N.G.A., R.C.M.; formal analysis, R.S.P.; investigation, D.F.O.; data curation, A.T.GM.M.; writing-original draft preparation, D.F.O.; writing-review and editing, M.H.N.G.A., R.S.P. and R.C.M.; supervision, R.C.M.; project administration, R.C.M. All authors reviewed the manuscript and agreed to the published version of the manuscript.

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Availability of data and materials
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Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee of Universidade Federal de Minas Gerais, logged under protocol number 02396512.8.0000.5149. Written Informed consent was obtained from all subjects involved in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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