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TECHNOLOGICAL DEVELOPMENT RESEARCH

Construction and validation of an animated infographic on acute myocardial infarction pain: a methodological study*

Construção e validação de infográfico animado sobre dor do infarto agudo do miocárdio: estudo metodológico

Williane Morais de Jesus Gazos[1]
ORCID: 0000-0001-8713-7111

Francisco Marcelo Leandro Cavalcante[1]
ORCID: 0000-0001-6143-1558

Maria Girlane Sousa Albuquerque Brandão[2]
ORCID: 0000-0002-9925-4750

Nelson Miguel Galindo Neto[3]
ORCID: 0000-0002-7003-165X

Lívia Moreira Barros[1]
ORCID: 0000-0002-9763-280X

[1]University of International Integration of Afro-Brazilian Lusophony, Ceará, CE, Brazil
[2]University of São Paulo, São Paulo, SP, Brazil
[3]Federal Institute of Education, Science and Technology of Pernambuco, Pernambuco, PE, Brazil

Editors:
Ana Carla Dantas Cavalcanti
ORCID: 0000-0003-3531-4694

Paula Vanessa Peclat Flores
ORCID: 0000-0002-9726-5229

Vinicius Batista Santos
ORCID: 0000-0001-5130-5523

Corresponding author:
Francisco Marcelo Leandro Cavalcante
Email: marceloleandrocavalcante98@hotmail.com

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ABSTRACT

Objective: To describe the process of constructing and validating an animated infographic on acute myocardial infarction pain. **Method:** A methodological study conducted in the following stages: integrative review and situational diagnosis with the target audience for content gathering; development and validation of the script for the storyboard; construction and validation of the animated infographic prototype with experts and evaluation by the target audience. The validity of the technology was assessed by calculating the Content Validity Index and applying the binomial test, considering a minimum agreement proportion of 0.85. **Results**: Using multiple resources, such as illustrations, animations, text information, and audio narration, the animated infographic covered the following topics in six minutes and 38 seconds: definition of acute myocardial infarction; signs and symptoms of infarction; pain identification; risk factors and epidemiological data; necessary care in the event of suspected infarction. In both expert validation and target audience evaluation, a global Content Validity Index of 0.98 was obtained in both evaluations. **Conclusion**: The infographic was considered valid and suitable for health education about myocardial infarction, and it may help improve learning and decision-making among the lay populations.

Descriptors: Myocardial Infarction; Emergency Identification; Health Education; Educational Technology; Animation.

RESUMO

Objetivo: Descrever o processo de construção e validação de um infográfico animado sobre a dor do infarto agudo do miocárdio. **Método:** Estudo metodológico realizado nas seguintes etapas: revisão integrativa e diagnóstico situacional com o público-alvo para levantamento de conteúdo; elaboração e validação do roteiro para o storyboard; construção e validação do protótipo do infográfico animado com experts e avaliação pelo público-alvo. A validade da tecnologia foi avaliada pelo cálculo do Índice de Validade de Conteúdo e pela aplicação do teste binomial, considerando-se uma proporção mínima de concordância de 0,85. **Resultados**: Com o emprego de múltiplos recursos, como ilustrações, animações, informações textuais e narração em áudio, o infográfico animado abordou, em seis minutos e 38 segundos, os seguintes conteúdos: definição do infarto agudo do miocárdio; sinais e sintomas do infarto; identificação da dor; fatores de risco e dados epidemiológicos; cuidados necessários na suspeita de infarto. Na validação com os experts e na avaliação pelo público-alvo, obteve-se um Índice de Validação de Conteúdo global de 0,98 em ambas as avaliações. **Conclusão**: O infográfico foi considerado válido e adequado para a educação em saúde sobre o infarto do miocárdio, podendo auxiliar na melhoria do aprendizado e na tomada de decisões pela população leiga.

Descritores: Infarto do Miocárdio; Identificação da Emergência; Educação em Saúde; Tecnologia Educacional; Animação.

INTRODUCTION

Cardiovascular diseases (CVDs), particularly ischemic heart disease (IHD), are among the leading causes of death worldwide and significant

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contributors to disability in the population. The final event in the IHD chain is acute myocardial infarction (AMI), characterized by the blockage of blood flow to the heart muscle, usually due to a clot or an atherosclerotic plaque[1-2].

The World Health Organization (WHO) estimates that in 2019, 17.9 million people died due to CVDs, representing 32% of all global deaths. Of these deaths, 85% were due to AMI and stroke[3]. In line with this, a systematic review and meta-analysis revealed that the global prevalence of AMI in individuals under 60 years old is 3.8%, while in those over 60 years old, this value rises to 9.5%[4].

In Brazil, the number of AMI hospitalizations increased by 54% between 2008 and 2019 in institutions belonging to the Unified Health System (SUS), with an inpatient mortality rate of 12.9% in 2019, highlighting AMI as a major public health issue[5]. Furthermore, following the COVID-19 pandemic, a significant increase in AMI cases has been observed, particularly among younger women and men[6].

Among the most common signs and symptoms of AMI are chest pain, sweating, dyspnea, fatigue, nausea, abdominal pain, syncope, jaw or epigastric discomfort, heart failure, and arrhythmia[7-8]. However, currently, one in five adults is unable to name a single symptom of a heart attack. As a result, many individuals with AMI symptoms arrive at the hospital too late or even die at home[9].

Given this scenario, it is emphasized that hospitalization and mortality rates from these diseases can only be reduced through the establishment of healthcare services that utilize telemedicine, enabling electrocardiographic diagnosis and clinical assistance, the organization of reference services, the provision of qualified pre-hospital care, and, especially, the promotion and education of the population regarding health. These measures make reliable information available and increase the collective knowledge of the signs and symptoms of AMI and the necessary actions to ensure timely specialized care[1-2].

In this context, among the health education strategies, educational technologies stand out as tools that promote lifestyle changes, increase self-efficacy, and encourage awareness and shared responsibility for self-care by the target audience, through the construction of knowledge and skills in a playful, dynamic, participatory, interactive, and engaging way[10].

Among the educational technologies that have gained prominence in the health field are infographics, which can be classified as static, interactive, and/or animated. Animated infographics use communication based on sound and visual elements to synthesize and disseminate knowledge in a simple, quick, attractive, and engaging manner[11].

Animated infographics enable the incorporation of various content, making it accessible to diverse audiences by using resources such as illustrations, animations, audios, videos, texts, and photos. Furthermore, they can be made available on digital platforms and accessed via smartphones, tablets, computers, and laptops[12].

In this regard, with the aim of contributing to the Third Sustainable Development Goal established in 2015 by the United Nations, "Good Health and Well-being," and in response to the scarcity of educational materials and the lack of animated infographics on AMI for the general public, the development of an animated infographic was envisioned as a tool to be used in educational approaches on the pain of myocardial infarction.

The development and validation of educational technologies on this topic can contribute to the training of the population in emergency situations such as AMI, considering that laypeople often have knowledge deficits and take inadequate actions when faced with the signs and symptoms of a heart attack[13-15]. In this way, a well-informed population can be better prepared to respond to and provide initial care when witnessing emergencies such as AMI, which can promote swift diagnosis and treatment and reduce mortality rates[16].

Thus, this study enables the provision of an innovative audiovisual educational resource that can be used in individual and collective health education on the aforementioned topic. The aim is to promote user autonomy by allowing them to access standardized, evidence-based instructions whenever they wish and as many times as they deem necessary. In light of this, the objective of this study was to describe the process of building and validating an animated infographic on the pain of AMI.

METHOD

This is a methodological study on the development and validation of an educational technology, an animated infographic, for health edu-

cation of the lay population about the pain of AMI. To better structure and report this study, the guidelines from the Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) were adopted.

The construction and evaluation stages of the infographic were conducted from July to November 2022 by a team composed of graduate nursing students, a faculty member with a PhD in nursing, and a graphic designer.

For the methodological development, the study was structured around the following stages: integrative literature review; situational diagnosis through interviews with the target audience; development and validation of the storyboard script; construction of the educational technology in the form of an animated infographic; content and appearance validation of the infographic with experts; and apparent validation of the technology with the target audience[17]. Furthermore, the theoretical framework for the development of this educational technology was based on the Cognitive Theory of Multimedia Learning (CTML) applied to the use of infographics, which aims to guide the learner through the appropriate cognitive process, with greater information retention and less effort required to understand the content[18].

To develop the animated infographic, the planning and production stages were carried out as outlined in Figure 1.

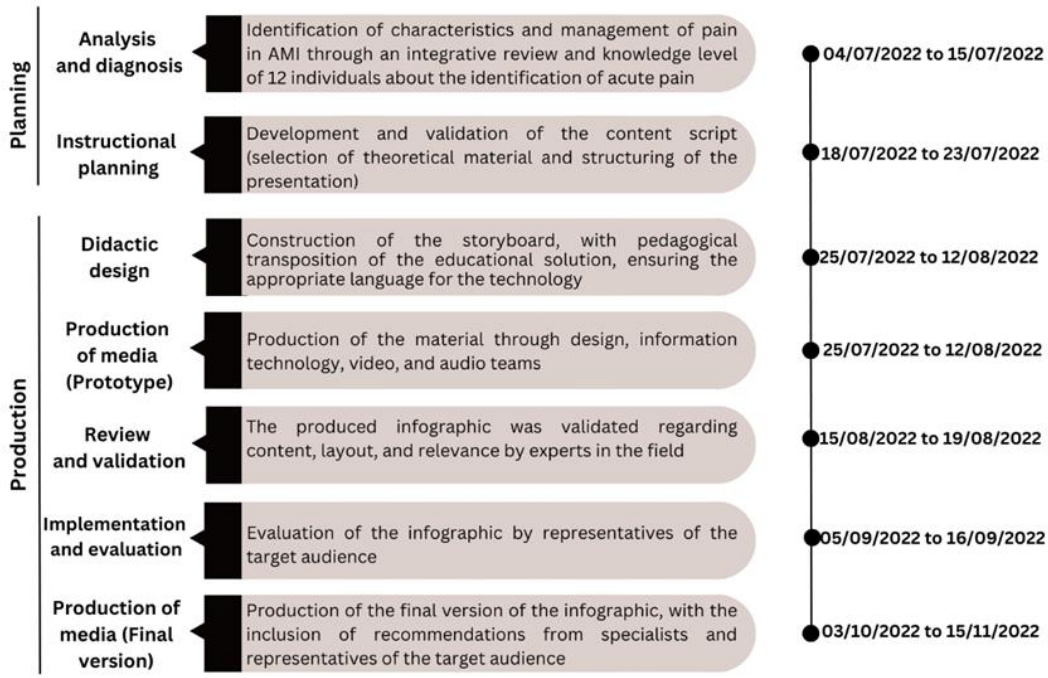

Figure 1 - Stages of development of the animated infographic. Redenção, CE, Brazil, 2022

In the analysis and diagnosis phase, the content for the infographic was gathered through two previous studies. Initially, an integrative literature review was conducted based on the guiding question "What are the characteristics and management of pain in AMI?", with searches in the PubMed/Medline, Web of Science, Scopus, LILACS, and CINAHL databases. Eleven articles were selected for the final sample, which served as the basis for the development of the infographic script. Subsequently, the knowledge of lay people regarding the identification of AMI pain was assessed. In this phase, a qualitative study was conducted with 12 patients who had two or more cardiovascular risk factors and were waiting for treatment in an Emergency Care Unit (UPA, in Portuguese) in Fortaleza/CE, Brazil. To prompt responses, the following question was asked: "What is AMI for you?". The responses were analyzed using IRAMUTEQ®, and it was found that the participants lacked knowledge about the subject, particularly regarding the recognition of AMI signs and symptoms.

Based on the findings from the previous studies, the infographic script was developed in Microsoft Word 2016, containing the educational content and instructions for the graphic de-

signer regarding the creation of characters, illustrations, and animations, as well as the layout of the topics on each screen of the educational technology. The script was then validated with five nurses who specialized in emergency care. These professionals were identified through consultation with the Lattes Platform of the National Council for Scientific and Technological Development (CNPq), and selected based on the criteria of Jasper (1994)[19]. For each expert, a data collection instrument created in Google Forms® was sent via email, containing the Informed Consent Form (ICF), the link to access the animated infographic via Google Drive, a demographic/professional characterization instrument, and the Health Education Content Validation Instrument (IVCES), which includes 18 evaluation items subdivided into three domains: objectives, structure/presentation, and relevance. For each item, the experts rated the content using a Likert-type scale: 0 – Inadequate; 1 – Partially adequate; and 2 – Adequate[20].

After validating the script, the prototype of the educational technology was produced in three substeps: instructional design, media production, and content and appearance review and validation. In the instructional design step, the educational tool was pedagogically transformed through the creation of the storyboard. All stages followed the principles of the Cognitive Theory of Multimedia Learning (CTML)[21].

The researchers, together with the graphic designer, defined the images, illustrations, and animations that would represent the content described in the storyboard script. The textual content of the infographic script was then recorded by the principal investigator using an iPhone 11 smartphone audio recorder and sent to the graphic designer for integration and synchronization with the screens of the educational technology.

In the review and validation phase, the produced infographic was analyzed for content, layout, and relevance. Nurses with expertise in emergency care participated in this stage. To establish the sample size, the infinite population formula was used: $n = Z\alpha^2.P.(1-P)/d^2$, where Zα: confidence coefficient (95% - 1.96); P: proportion of agreement among the experts; and d: acceptable difference from the expected, resulting in a sample size of 22 nurses[22].

The specialists were selected according to the criteria proposed by Jasper (1994)[19], with consultation to the Lattes Platform, as well as through study and research groups in the field of Emergency Nursing to identify professionals suitable for participation in the research. Furthermore, snowball sampling was used.

For data collection, an invitation letter to participate in the research and the link to the Google Forms® containing the Informed Consent Form (ICF), the storyboard of the animated infographic, the socio-demographic/professional characterization questionnaire, and the Health Education Content Validation Instrument (IVCES)[20] were sent by email to each specialist.

Subsequently, after making adjustments based on the specialists' suggestions, implementation and evaluation were carried out with the target population. This phase took place in the waiting room of the aforementioned healthcare service. The sample size was also determined using the infinite population formula: $n = Z\alpha^2.P.(1-P)/d^2$, resulting in a sample of 22 participants[22]. Participants were selected by convenience, and the inclusion criteria were: adult patients with two or more risk factors for cardiovascular diseases. The exclusion criteria were: individuals with intellectual limitations and those with hemodynamic instability that would prevent participation in the study. Participants were informed of the risks, benefits, and rights associated with participation and signed the ICF.

Next, the animated infographic was displayed on the television in the UPA waiting room. The researcher was available to provide clarifications and address any questions. Afterward, participants responded to the data collection questionnaire, which consisted of two parts: socio-demographic data and an instrument for apparent validation of the technology, adapted from Galindo Neto's study[23]. This instrument contains 14 questions that evaluate the educational technology in aspects such as interactivity, objectives, relevance, effectiveness, and clarity. For each item, participants assigned a score on a Likert scale: 0 – Inadequate; 1 – Partially adequate; and 2 – Adequate.

The collected data were organized in Google Sheets® spreadsheets. The generated database was later exported to the Statistical Package for the Social Sciences (SPSS) program, which was used to perform descriptive and analytical statistical analysis. The validity of the script and storyboard of the animated infographic was assessed using the Content Validity Index (CVI), which calculated the global CVI

and the CVI for each item of the validation instrument (I-CVI). A minimum proportion of agreement of 0.85 was considered. Additionally, the binomial test was applied to verify the statistical significance of the items that received agreement from the experts, with a significance level of 5%.

The study adhered to Resolution 466/2012 of the National Health Council and received approval from the Research Ethics Committee of the University of International Integration of Afro-Brazilian Lusophony (UNILAB), as per CAAE number: 56314522.1.0000.5576, Official Letter No. 5468713/2022.

RESULTS

After identifying the educational content for the animated infographic during the planning stage, the script for the technology was structured around the following topics: definition of AMI; description of AMI pain and its identification; signs and symptoms; risk factors for the disease; and care in case of suspected AMI. The educational information was adjusted to an accessible and non-technical language to facilitate understanding by the target audience. In this context, the script for the animated infographic was considered adequate by the specialists, receiving 100% agreement (p=1) on all items assessed by the Health Education Content Validation Instrument (IVCES).

In constructing the storyboard, each screen of the infographic was created, containing illustrations associated with textual information and audio narration. To assist in demonstrating and guiding the presented information, as well as to promote interaction with the viewer, three characters were created: Cisco (the infographic mascot), Williane (UPA nurse), and João (patient), as illustrated in Figure 2.

Figure 2 – Characters of the animated infographic. Redenção, CE, Brazil, 2022

Subsequently, the prototype of the infographic was constructed, integrating each screen and synchronizing the recorded audio. Figure 2 presents examples of the screens from the animated infographic.

Figure 3 – Version of the animated infographic prototype on acute myocardial infarction pain. Redenção, CE, Brazil, 2022

The first version of the animated infographic had a duration of 6 minutes and 35 seconds. This version was validated by 22 nurses with professional experience and specialization in the field of emergency and urgent care, achieving a global Content Validity Index (CVI) of 0.98. Table 1 presents the data obtained during the validation with the specialists, where all items achieved a CVI-I ≥ 95%.

Table 1 –Distribution of experts' agreement on the content validation of the animated infographic on acute pain in myocardial infarction (N=22). Redenção, CE, Brazil, 2022

Items	n (%)	I-CVI*	p**
Objectives			
1. Consider the proposed theme	21 (95.5)	0.95	0.972
2. Suitable for the teaching-learning process	22 (100.0)	1	1
3. Clarifies possible doubts about the topic discussed	21 (95.5)	0.95	0.972
4. Provides reflection on the topic	21 (95.5)	0.95	0.972
5. Encourages behavior change	22 (100.0)	1	1
Structure and presentation			
6. Language appropriate to the target audience	22 (100.0)	1	1
7. Language appropriate to educational material	21 (95.5)	0.95	0.972
8. Interactive language, allowing active involvement	21 (95.5)	0.95	0.972
9. Correct information	22 (100.0)	1	1
10. Objective information	22 (100.0)	1	1
11. Clarifying information	22 (100.0)	1	1
12. Necessary information	22 (100.0)	1	1
13. Logical sequence of ideas	22 (100.0)	1	1
14. Current theme	22 (100.0)	1	1
15. Appropriate text size	22 (100.0)	1	1
Relevance			
16. Animated infographic stimulates learning	21 (95.5)	0.95	0.972
17. Contributes to knowledge in the area	22 (100.0)	1	1
18. Awaken interest in the topic	21 (95.5)	0.95	0.972

* Item-level Content Validity Index; **Binomial test.

The animated infographic was considered valid by the specialists, achieving a global Content Validity Index (CVI) of 0.98. As modifications, the nurses suggested presenting open-ended questions to stimulate reflection; reinforcing the illustration of the infarcted area due to the atheroma plaque; using the term "middle of the chest" instead of "sternum" and "physical exertion" instead of "physical exercises"; changing the phrase "in cases of suspected infarction" to "what should I do if I suspect an infarction?"; and including representative images of UPA, hospital, and the Mobile Emergency Care Service (SAMU in Portuguese) ambulance. These recommendations were promptly implemented in the infographic.

After implementing the specialists' suggestions, the appearance of the infographic was evaluated by 22 patients with at least two cardiovascular risk factors. In this stage, a global CVI of 0.98 was obtained. Only one item, related to the infographic's ability to promote interaction and active involvement in the educational process, showed an I-CVI below 85%, as shown in Table 2.

It is worth noting that only one participant suggested a modification to the infographic, regarding the change of colors used in the technology, which were considered too dark. However, the suggestion was not accepted, as a color palette was chosen that was appropriate for the theme, the illustrations, and the environment proposed for the infographic. Additionally, no other significant modifications were made to the educational technology, such as changing the colors of the infographic. After the validation rounds, the final version of the animated infographic lasted 6 minutes and 38 seconds.

DISCUSSION

The decision to create an animated infographic on the identification of acute pain from STEMI (ST-segment elevation myocardial infarction) for the lay population arose from the realization that there was no educational technology addressing the specificities of STEMI pain for this audience, following a review study[24]. Thus, the availability of the animated infographic on STEMI will enable nurses to implement innovative and engaging evidence-based educational interventions, supported by this technology.

The choice of the animated infographic was also due to the ease of understanding the content in an attractive manner with high explanatory potential, derived from various visual elements combined with descriptive audio and concise, objective written text[25]. With such features and audiovisual format, this technology could be implemented in various healthcare services, enhancing waiting rooms as educational spa-

Table 2 -Distribution of target audience agreement regarding the evaluation of the animated infographic on acute pain from myocardial infarction (N=22). Redenção, CE, Brazil, 2022

Items	n (%)	I-CVI*	p**
Interactivity			
1. Content is tailored to your needs	22 (100)	1	1
2. Offers interaction, active involvement in the educational process	18 (81.8)	0.81	0.424
3. Allows you to easily access the topics presented	19 (86)	0.86	0.661
4. Provides autonomy to the user in relation to its operation	22 (100)	1	1
Objectives			
5. Encourages learning about the content covered	22(100)	1	1
6. Encourages learning of new concepts	22 (100)	1	1
7. Allows you to search for information without difficulty	22 (100)		
8. Has an attractive presentation strategy	22 (100)	1	1
Relevance and effectiveness			
9. Provides the appropriate and necessary resources for its use	22 (100)	1	1
10. It sparks your interest to use it	22 (100)	1	1
11. Encourages behavior change in you	22 (100)	1	1
12. Reproduces the content covered in different contexts	22 (100)	1	1
Clarity			
13. Presents information in a simple way	22 (100)	1	1
14. Allows you to reflect on the content presented	22 (100)	1	1

* Item-level Content Validity Index; **Binomial test.

ces, and enabling outreach to different audiences with varying levels of education to disseminate information on the topic. The development of the technology resulted in an animated infographic with a short duration (6 minutes and 38 seconds). This aligns with another study that developed an animated infographic on safe medication in children's health, with a similar duration (6 minutes and 26 seconds)[26]. This aspect is significant as it allows the subject to be clarified in a more attractive, accessible, and motivating way, increasing the interest of the viewing audience.

It is worth emphasizing that the development of the infographic was based on the principles of the Active Teaching-Learning Cycle Model (TCAM)[27], which reinforce the construction of knowledge by learners through the combination of words and illustrative images. This aspect enables more effective learning, as the arrangement of visual, textual, and narrated audio information provides dual reinforcement of the content, allowing viewers to make associations that enhance learning and promote greater retention of knowledge in the short, medium, and long term.

In line with this, during the creation of the script, careful attention was paid to using accessible, clear, and easily understandable language for the audience, especially individuals with low levels of education. Similar studies adopted the same care when selecting content for educational technologies aimed at the lay population, using everyday words and omitting scientific terms[18,28].

The content included in the script was validated by expert nurses before the construction of the storyboard. This aligns with previous studies, proving to be relevant, as it ensures better suitability of the educational information, provides better direction for the creation of illustrations to be used in the educational technology, and helps achieve the technology's objectives[29-30].

In this context, it is emphasized that the didactic design was achieved through the active involvement of the graphic design professional, under the guidance of the researchers. The input from various professionals and specialists in the development of educational materials was an essential aspect, corroborating other studies on the construction and validation of technologies that involved technical support from professionals in the fields of computer science, graphic design, communication, and advertising[31-32].

The assistance of the graphic designer enabled the careful selection of images and colorful illustrations to convey the content more effectively, helping capture attention, stimulate imagination, and promote information retention. The use of characters was also crucial for mediating the presentation of information, helping draw the participant's attention to important details. These aspects are essential for promoting motivation, interest, and interaction with the audience, facilitating their acceptance and identification with the educational technology, which can make the learning process and

knowledge construction easier[33]. Research on the use of digital tools supports the idea that characters create a connection with the target audience[28].

The final validation of the infographic with expert nurses in the field brought greater adequacy and validity to the construct developed. This validation process is necessary in the construction of technologies to ensure credibility regarding their appropriateness, which is essential for their applicability, and is a common procedure in studies on the validation of educational health technologies[34-35].

The evaluation with representatives of the target audience was conducted with individuals at cardiovascular risk. This evaluation process with the final users was positive, as seen in previously developed technologies, offering an analysis of the clientele's perspective and the opportunity to implement improvements before the official release[25].

Given the above, the developed infographic is a technological innovation that can contribute to the dissemination of knowledge about AMI pain, offering quick access at a low cost in different settings, including health service waiting rooms or even on the clients' mobile phones. Additionally, it can be used in classes, lectures, and scientific discussions with students and healthcare professionals to build and update knowledge on the topic.

Regarding the limitations of this study, the cost of developing the animated infographic is highlighted, which may compromise the feasibility of developing similar technologies, as financial support from funding agencies is often scarce. Furthermore, the sample composition of the target audience was based on convenience, which may limit the representativeness of the general population.

CONCLUSION

In the present study, an animated infographic with a duration of 6 minutes and 38 seconds was developed and validated to guide the identification and management of AMI pain. The technology addressed information such as the definition of AMI, epidemiological aspects of the disease, signs and symptoms of the condition, guidance for identifying pain, cardiovascular risk factors, and appropriate care in case of suspected AMI.

Moreover, the infographic was considered valid by both experts and the target audience, achieving a global IVC of 0.98 in both evaluations. According to the participants' assessment, the animated infographic is an appropriate, clear, and objective educational tool that uses multimedia elements such as textual information, audio, animations, and illustrations, facilitating the construction and retention of knowledge.

Thus, the animated infographic stands out as a potential technology for health education and promotion, carried out by nurses and other healthcare professionals. It can be used as a complementary strategy in interventions and health education and prevention programs about AMI.

Finally, it is emphasized that future experimental studies are needed to assess the effectiveness of the infographic in improving the general population's knowledge about AMI, as well as to investigate its short-, medium-, and long-term impact on adherence to preventive measures for this condition.

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CONFLICT OF INTERESTS

The authors have declared that there is no conflict of interests.

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AUTHORSHIP CONTRIBUTIONS
Project design: Gazos WMJ, Barros LM
Data collection: Gazos WMJ
Data analysis and interpretation: Gazos WMJ, Cavalcante FML, Brandão MGSA, Galindo Neto NM, Barros LM
Writing and/or critical review of the intellectual content: Gazos WMJ, Cavalcante FML, Brandão MGSA, Galindo Neto NM, Barros LM
Final approval of the version to be published: Gazos WMJ, Cavalcante FML, Brandão MGSA, Galindo Neto NM, Barros LM
Responsibility for the text in ensuring the accuracy and completeness of any part of the paper: Gazos WMJ, Cavalcante FML, Brandão MGSA, Galindo Neto NM, Barros LM