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Is stroke knowledge retained? Four-year longitudinal data of *FAST Heroes* campaign

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Introduction: Educational stroke programs seem to increase awareness about stroke management. However, there is a speculation that actual stroke knowledge post mass campaign implementation remains poor. The aim of the present study was to evaluate stroke knowledge retention four years post *Fast Heroes* program implementation, an interactive stroke educational program, in school-aged children without any follow up during this time.

Methods: Seventy-eight ($n = 47$ had attended the program four years ago and $n = 31$ had never attended the program) school-aged children completed the age-adjusted online preparedness questionnaire during class four years post program implementation. The variables used to measure campaign effectiveness were knowledge of: i) stroke symptoms described in the FAST acronym (Face-Arm-Speech), ii) appropriate course of action (i.e., calling an ambulance), and iii) the European emergency number (i.e., 112).

Results: In all questions, children that had attended the program had 14–81% greater chances to answer correctly.

Discussion: There is still knowledge gain even four years post program implementation with no follow up during that time. The design of the campaign (i.e., 5-week duration, age-appropriate exercises, cartoon animations, song and dance elements, sentimentally driven activities and 3-layer education dissemination) facilitates long-term knowledge retention and may have led to the knowledge gains observed. Broad implementation potentially as part of the annual curriculum in schools can impact community stroke knowledge and should be considered.

KEYWORDS

stroke, stroke campaign, children, knowledge retention, *Fast Heroes* program

Introduction

Worldwide, stroke ranks as the second and third leading cause of mortality and morbidity, respectively (Feigin et al., 2022). Its incidence is expected to rise even further, with the increasingly aging global population (United Nations, 2017). Studies have highlighted the crucial role of knowledge in achieving improved health outcomes (Raghupathi and Raghupathi, 2020). Indeed, research examining knowledge retention in stroke-related health campaigns has demonstrated significant disparities in knowledge gains between the intervention and the control groups (Marx et al., 2008; Nordanstig et al., 2017; Zhong et al., 2020).

Various studies have shown that children serve as effective conduits for disseminating stroke knowledge to a wider population, including parents, grandparents, and extended family members (Williams et al., 2012; Amano et al., 2014; Matsuzono et al., 2015; Ishigami et al., 2017; Kato et al., 2017; Marto et al., 2017; Tomari et al., 2017; Hino et al., 2018; Tsakpounidou and Proios, 2021; Proios et al., 2022; Tsakpounidou et al., 2022). *Fast Heroes* program is an interactive stroke educational program aimed at equipping schoolchildren with the ability to identify stroke symptoms promptly and act appropriately in case of suspected stroke (i.e., calling immediately the emergency number 112 for an ambulance). The *FAST Heroes* campaign is based on the FAST acronym (Face, Arm, Speech, Time). In addition, the program's structure facilitates the transfer of knowledge to parents and grandparents, thus encompassing the extended family network (Tsakpounidou et al., 2020). Children spend a significant amount of time with their grandparents who seem to play a substantial role in their upbringing across cultures (Pulgaron et al., 2016). Children like sharing what they find interesting and, in doing so, they develop self-regulatory skills, while solidifying their own knowledge (Cortese, 2005; Hattie and Donoghue, 2016). The emotional bond between a child and its parent/grandparent may facilitate information retention (Tyng et al., 2017). As highlighted by Hermida et al. (2021), the motivation fostered within the parent-child relationship facilitates the transfer of knowledge. Parents possibly pay greater attention to what their child has to say compared to an unfamiliar expert or another child. Consequently, knowledge propagation through children creates a mutually beneficial situation for all parties involved, including children and their relatives.

The program incorporates certain health-communication disciplines. One framework that has been used to theoretically ground the program is the Two-Step Flow Theory (Lazarsfeld et al., 1944; Katz and Lazarsfeld, 1955). According to this theory, a campaign first influences the opinion leaders and these leaders then influence others. In our case, grandchildren act as opinion leaders. The *FAST Heroes*' campaign content resonates with schoolchildren, encourages them to convey the campaign's message to a wider population (e.g., their parents, grandparents and family friends, who we refer to as the extended family) and this may contribute to its effectiveness. Another framework that the program has been based on is the Child-Mediated Stroke Communication (CMSC) model in which children act as conduits to transfer knowledge to the extended family (Williams et al., 2012). Participation to school interactive games and sessions and supplemental home activities are requisites to ensure that the effects of the educational program are long-lasting (Ishigami et al., 2017). This communication method may act as positive reinforcer of program participation to corroborate the program's effectiveness and sustainability.

Largely, in terms of post campaign knowledge retention among children (Williams and Noble, 2008; Sakamoto et al., 2014; Williams et al., 2018), parents (Shigehatake et al., 2014; Matsuzono et al., 2015; Ishigami et al., 2017; Kato et al., 2017; Marto et al., 2017; Hino et al., 2018), and grandparents (Proios et al., 2022), there is typically an improvement in knowledge compared to pre-campaign knowledge. However, Hickey et al. (2018) reported that

actual stroke knowledge following mass campaign implementation remains poor.

Nevertheless, it is still necessary for longitudinal data regarding the post-campaign knowledge retention of stroke symptomatology and proper course of action to be presented, so as to see if stroke knowledge is retained and if stroke related health campaigns can actually produce long-term results. The *Fast Heroes* program has been shown to produce rather promising results with regards to knowledge gains post-implementation (Tsakpounidou et al., 2020, 2022; Tsakpounidou and Proios, 2021). The results of the global cross-country *Fast Heroes* educational campaign, involving 4,202 participants showed that immediately after post-implementation 70% of the participants knew the correct response for all three stroke symptoms, 83% could accurately identify each of the three symptoms, and 85% knew the correct emergency number (Tsakpounidou et al., 2022). What this study aimed to investigate was whether this knowledge gains could be successfully retained over longer periods of time.

To the best of our knowledge, there is no data on post campaign longitudinal stroke knowledge retention. During our literature search, we only found the Nordanstig et al. (2017) study which examined the impact of the Swedish national stroke campaign on stroke awareness 21 months after the program was implemented in adults. The study randomly selected 1,500 adults at eight different time periods: before, three times during, immediately after, 13 months, and 21 months after the campaign implementation. The results showed that knowledge retention 21 months post-intervention had been increased substantially. In particular, prior to the campaign, 4% of participants could recall the meaning of some or all keywords in the AKUT test (a Swedish equivalent of the FAST test) and intended to call the emergency number. In comparison, during and immediately after the campaign, the numbers rose to 23% and after 21 months after the campaign it was 14%. Corresponding figures were 15, 51, and 50% for those remembering the term AKUT and 65, 76, and 73% for intent to call 112 when observing or experiencing stroke symptoms (Nordanstig et al., 2017). It is, therefore, necessary for longitudinal data to investigate whether stroke related health campaigns can produce long-term knowledge retention.

The Encoding-Decoding model is a communication model that helps explain how a campaign's message is remembered (Hall, 1973, 2003). This model emphasizes the role of encoding and decoding messages. Encoding refers to the dissemination of the campaign's message by the sender (campaign, i.e., *Fast Heroes* campaign) using verbal and non-verbal means. Decoding refers to the interpretation of the campaign's message by the receiver (target audience i.e., schoolchildren). For a campaign's message to be remembered effectively it is very important to consider both the encoding and decoding process. Based on the Encoding-Decoding Model (Hall, 1973, 2003) we hypothesize that children that had attended the *FAST Heroes* program four years ago, with no follow up during this time period, will have greater stroke-related knowledge than children that have never attended the program.

Methods

Participants

In December 2022, a total of seventy-eight fourth-grade children (i.e., 10 year old) from the same school completed an online stroke preparedness questionnaire during their class. Among them, 47 children had attended the *FAST Heroes* program four years ago, while attending kindergarten (Fast group). There was no follow up during these four years. Thirty-one children had never attended the program (Control group). At the time when the program was run in the kindergarten, these 31 children did not attend the specific school. The *FAST Heroes* program's details have been thoroughly described in a previous publication (Tsakpounidou et al., 2020).

Questionnaire

The questionnaire used in this study was based on the Stroke Preparedness Questionnaire (SPQ) (Tsakpounidou et al., 2022), but was slightly modified to account for age appropriateness (Please see Appendix). The variables used to measure the campaign's effectiveness were knowledge of stroke symptoms, described in the FAST acronym (Face-Arm-Speech), knowing the appropriate course of action in case of suspected stroke (i.e., calling for an ambulance) and familiarity with the European emergency number (i.e., 112).

The questionnaire was comprised of eight questions. One of the questions asked an open-ended response about the number to call for an ambulance, while the rest had a multiple choice format. Six questions were asking about the appropriate course of action that should be taken in case of various conditions. Three of these conditions were related to the stroke symptoms described in the FAST acronym, while the other three were related to health conditions irrelevant to stroke and of minor seriousness and urgency. In one multiple choice question, children had to select from a list of six choices, all the symptoms that are stroke-related. The questions were asked in a specific order for all children and they could not go back to previous questions to modify or review their response.

Procedure

Children were asked by their schoolteacher to complete the questionnaire online during their computer class lesson by the school administrator. Neither the teacher nor the children were previously notified about them filling out a questionnaire related to stroke preparedness. All answers were collected by the researchers online and they had no contact whatsoever with the schoolchildren. The study was approved by the Committee for Research Ethics of the University of Macedonia (Thessaloniki, Greece) (14/15:06.2020). The ethical permission is in accordance with the 1964 Declaration of Helsinki.

Statistical analysis

A one-sided hypothesis test was conducted to determine whether the *FAST Heroes* campaign training had a positive impact on strong-related knowledge and awareness among fourth-grade students in an elementary school who had attended the program four years ago. The test compared the responses of children that participated in the *FAST Heroes* program (Fast group) with the responses of children that did not attend the programme (Control group). The comparison focused on the proportions of correct answers that children gave in each one of the questions asked. The following hypotheses were tested:

$$H_0: p_{\text{FAST}} = p_{\text{Control}} \quad (1)$$

$$H_a: p_{\text{FAST}} > p_{\text{Control}} \quad (2)$$

Three alternative approaches were applied to test these hypotheses, namely: z-test for the comparison of proportions in two independent samples (using the pooled proportion), chi-square (X^2) test of homogeneity and Fisher's exact test. The Risk Ratio and the respective 95% confidence interval are calculated in each case.

Results

The results indicated that children who had attended the program four years ago were 24% more likely to recognize face drooping from one side as a stroke symptom compared to those who hadn't attended. Similarly, they had a 43% higher likelihood of identifying a weakened arm from one side as a stroke symptom, in comparison to children who hadn't participated in the program. Also, there was 29% greater change that children who had attended the program four years ago had a greater change to recognize incoherent speech as a stroke symptom as compared to children that had not attended the program (Figure 1).

The questions regarding the appropriate course of action in case of suspected stroke revealed that children who had attended the program four years ago were 32% more likely to call an ambulance when witnessing someone's face drooping on one side, as compared to children that had not attended the program. Additionally, there was a 14% greater chance that children who had attended the program would call for an ambulance in case they encountered someone that suddenly cannot move one arm. Finally, there was a 32% greater chance of children who had attended the program calling for an ambulance when they observed someone experiencing difficulty speaking clearly or mixing up their words as compared to children who had not attended the program (Figure 2).

There was 81% greater chance that children who had attended the program four years ago were aware of the European emergency number 112 to ask for an ambulance in case of suspected stroke as compared to children that had not attended the program (Figure 3).

Discussion

The present study demonstrated that children who participated in the *FAST Heroes* program four years ago with no follow-up

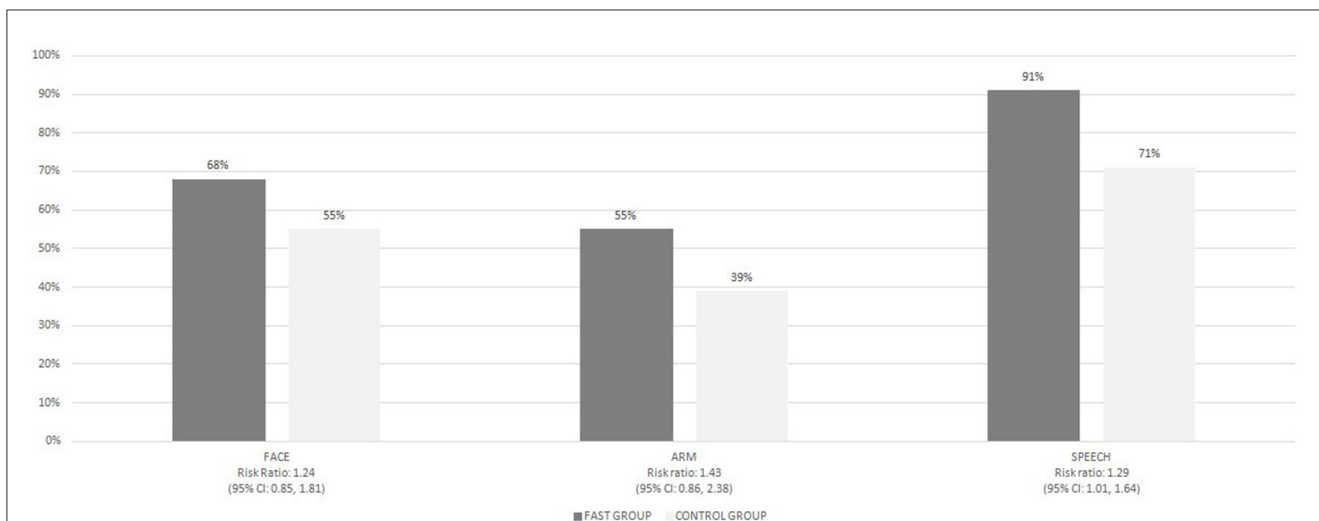


FIGURE 1 Participants' responses about which of the following are stroke symptoms. Fast group (n = 47), Control group (n = 31).

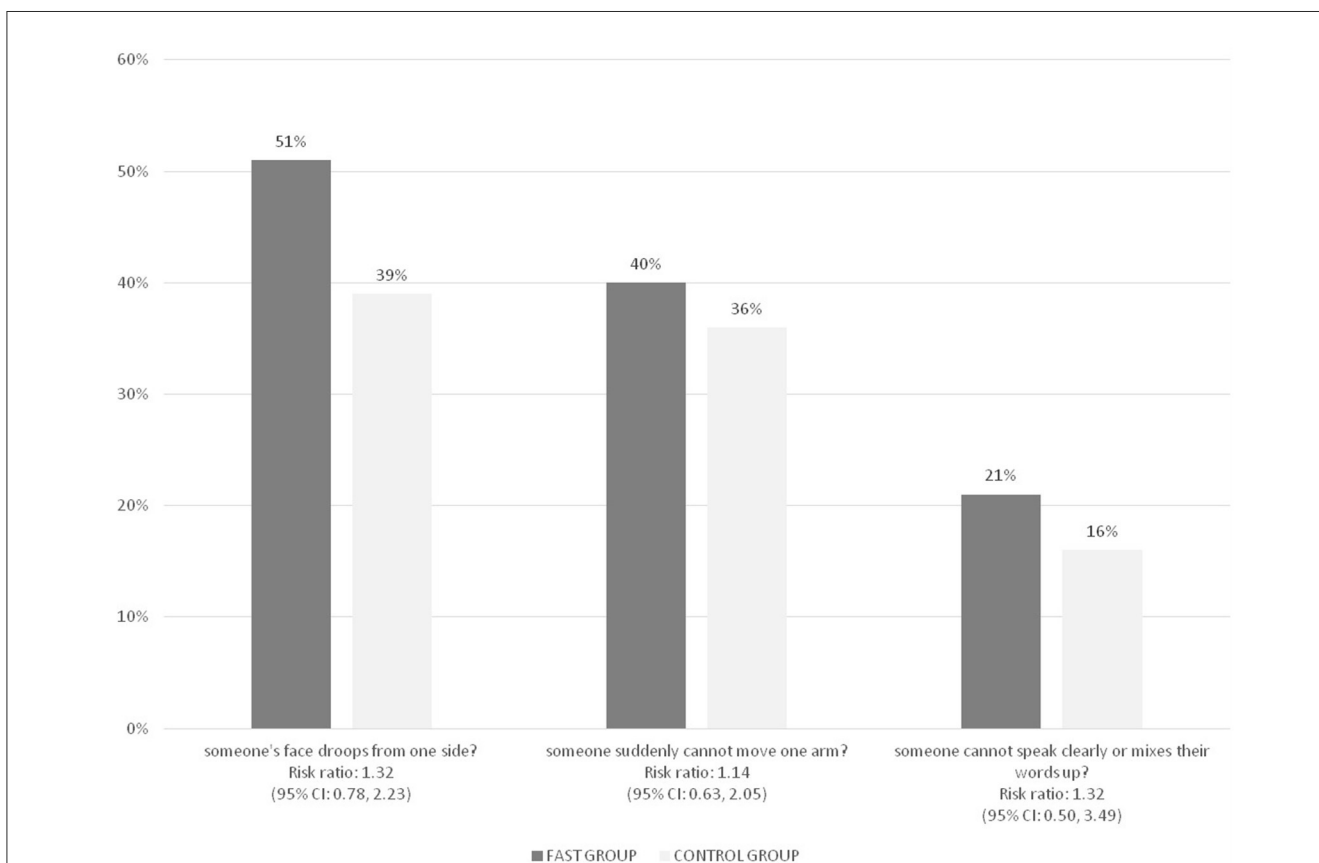
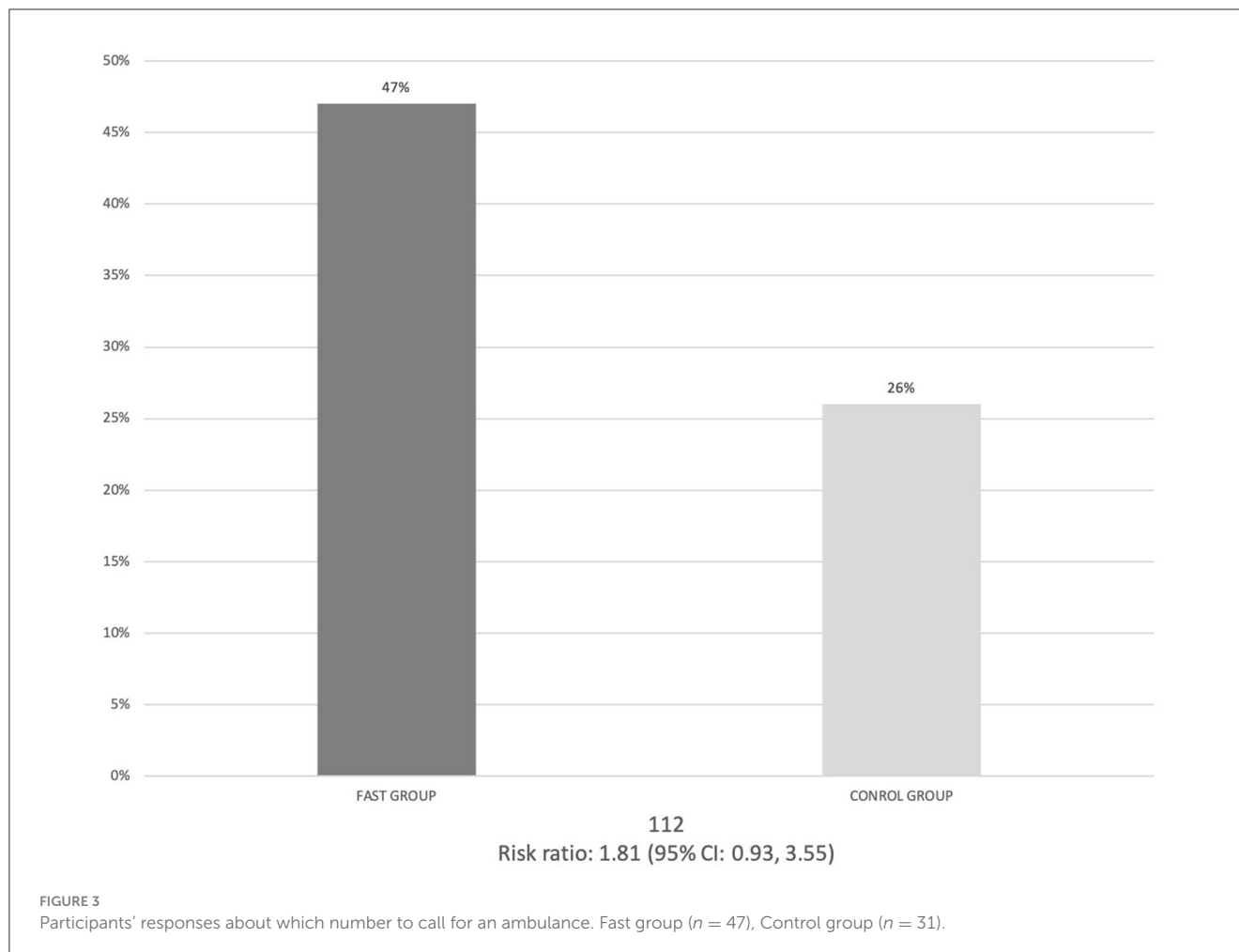


FIGURE 2 Participants' responses about what to do in case of suspected stroke. Fast group (n = 47), Control group (n = 31).

during this time period still retain stroke knowledge and their stroke-related knowledge is greater than children that had never attended the program. The participants had no additional stroke education in the meantime and had never been exposed to the questionnaire before. Based on the the Encoding-Decoding model (Hall, 1973, 2003), accurate decoding creates a more

effective and memorable communication process that increases the likelihood for the campaign message to be retained. *FAST Heroes* campaign's message has been tailored to the schoolchildren's values (learning, curiosity, responsibility), beliefs (friendship, family, reciprocity, empowerment) and experiences (entertainment and media consumption, imagination and play) to enhance accurate



decoding. Several factors, such as the five-week duration, the age-appropriate exercises, the cartoon animations, the song and dance elements, the sentimentally driven activities, and the three-layer approach to education dissemination may account for these results. All of above elements facilitate long-term knowledge retention.

The *FAST Heroes* program includes five lessons that are being taught within a five-week time period. This spacing effect has been found to enhance long-term memory retention compared to when information is presented in a hasty succession (Tabibian et al., 2019). The benefits of spacing out information are not solely confined to memory processes, but they also extend to simple and complex generalization processes (Vlach and Sandhofer, 2012).

Maybe the age-appropriate exercises intrigued children's desire to get involved with the program more essentially. According to Anker et al. (2016), campaigns that also incorporate (Supplementary material) and services such as brochures or community groups seem to disseminate the campaign message more effectively. The *FAST Heroes* program provides multiple channels for effective learning such as an activity book, well-designed cartoon animations, and interactive website to support the campaign's goal. Graphics, animation, and cartoon characters used in multimedia increase student motivation. They are considered successful tools for enhancing children's memory by engaging their attention, activating encoding and recall mechanisms and

ensuring that information is stored in memory for a longer period of time (Nusir et al., 2013; Obali, 2021, p. 62–63). In addition, the program contains theatricality with role playing, song and dance elements. Role playing is linked to memory, self-regulation, an essential way for children to learn (Kingdon, 2018). Songs can serve as mnemonic devices, enhancing memorability (Crowther, 2012). Dancing contributes to experiential learning by involving relevant memory cues such as visual, tactile and kinesthetic elements (Payne and Costas, 2021).

The impact of emotion on learning and memory is of great interest because emotion exerts great influence on learning thus manages selective attention, facilitates long-term memory retention, and enhances the encoding and retrieval of information (Tyng et al., 2017). The *FAST Heroes* program includes sentimentally driven activities, where children are encouraged to draw pictures of their real-life super heroes, i.e., their grandparents, and explain why they consider them as their super heroes. This is another element of the study that may have resulted in knowledge gain even four years post program implementation. As it has already been said, learning through teaching constitutes an effective way of learning (Hermida et al., 2021). Children teach their parents and grandparents about stroke, as indicated in the Two-Step Flow Theory. In *FAST Heroes* program, there is a three-layer education dissemination approach, where the person

who acquires the knowledge actively passes it on to his/her relatives based on the CMSC. According to Noar (2006), message design involvement is one of the three fundamental pillars that affect campaign effectiveness.

In all questions, it was observed that the ten-year old children who had attended the program four years earlier demonstrated greater stroke knowledge than their classmates that had not attended the *FAST Heroes* program. However, it is worth noting that even the children who had never attended the program displayed some level of knowledge with regards to stroke. One possible explanation of this could be attributed to the presence of posters on the school's walls, which were put up after the program implementation. These posters may have further facilitated the engagement with the *FAST Heroes* program, through conversations among students who have participated or by sparking the children's curiosity to visit the program's website. The impact of mere poster-hanging in schools and public areas will be further investigated in relation to the knowledge gains.

The present study identifies several areas for potential research growth. In particular, addressing the knowledge-behavior gap in the present program should be a focus of future research. While knowledge alone may not be sufficient, it is a necessary part of the process of behavioral change (Raghupathi and Raghupathi, 2020). Health campaigns, as noted by Snyder et al. (2004), have an overall positive impact on behavior change compared to the effect of no campaign at all. The concept of self-efficacy, as proposed by Bandura's social cognitive theory (Bandura, 1977), plays a crucial role in closing the gap between knowledge and behavior (Rimal et al., 1999; Anker et al., 2016). Self-efficacy refers to a person's belief in his/her ability to act in such a way in order to produce the desired outcome. The *FAST Heroes* program uses a "learn by teaching" approach, which enhances both surface and deep learning while promoting self-regulation (Hattie and Donoghue, 2016). Self-regulation and self-efficacy are interrelated concepts. The former refers to the person's strategy to achieve a specific behavior, while the latter refers to the person's belief that he/she can succeed. Furthermore, the study's limitations, including the small sample size, limited geographical scope, and the specific age group studied, pose challenges to the generalizability of the results to the broader population. It is worth noting that the study did not account for other potential sources of stroke-related knowledge that children may have encountered during the four-year period. Consequently, attributing the observed knowledge gains in children who participated in the program four years ago solely to the *FAST Heroes* program may not be comprehensive.

We demonstrated that *FAST Heroes* program shows long-term knowledge gains in a health topic that affects the lives of millions of people. Usually, similar health related programs are conducted only in training for emergency situations. Considering their potential, in the future we suggest that they should be integrated in the school curriculum as part of a national annual educational program.

Theoretical and practical implications

Hall's theoretical framework applies to a health-related school-based campaign. The theory contributes to understanding

how an effective campaign is designed to deliver memorable information. From the encoder's perspective, the campaign needs to take into account the decoder (i.e., schoolchildren) in order for the message to be memorable. That is why the *FAST Heroes* program concentrated on aspects like time duration, story plot, cartoon animations, song and dance elements, theme meaning and five-week duration, the age-appropriate exercises, the cartoon animations, the song and dance elements, the sentimentally driven activities, learning through teaching.

Sustainability in health care is crucial to support human wellbeing and health (Molero et al., 2021). Sustainability on health refers to ensure equality in everyone's life quality (Malikhao, 2020). In order for sustainability on health to be feasible, health communication should be practiced. *FAST Heroes* program engages schoolchildren to upgrade the health literacy level of their grandparents so that the latter group knows how to react in case of suspected stroke. Enhancing stroke knowledge nationally and worldwide could lead to a future reduction of onset-to hospital-door time and more lives saved.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Committee for Research Ethics of the University of Macedonia (Thessaloniki, Greece) (14/15:06.2020). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MB: Conceptualization, Supervision, Visualization, Writing—original draft, Writing—review & editing, Methodology. KT: Data curation, Methodology, Project administration, Writing—original draft, Writing—review & editing. JV: Funding acquisition, Project administration, Writing—review & editing. CK: Data curation, Formal analysis, Software, Validation, Writing—original draft. MP: Data curation, Investigation, Writing—review & editing. HP: Funding acquisition, Supervision, Writing—review & editing, Project administration, Visualization.

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Conflict of interest

JV was employed by Boehringer Ingelheim.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcomm.2023.1264423/full#supplementary-material>

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