











ARTIGO - ARTICLE - ARTÍCULO

Treinamento em primeiros socorros em escolas públicas e privadas brasileiras de ensino médio: resultados e perspectivas

First aid training in Brazilian public and private high-schools: Outcomes and perspectives

Formación en primeros auxilios en escuelas secundarias públicas y privadas brasileñas: resultados y perspectivas

Thiago Santos Evangelista¹ , Denize Palmito dos Santos² , Cristiane Maria dos Santos¹ , Fernanda de Souza Teixeira¹ 
 Janderson da Costa Albano¹ , Julio Cezar Souza Vasconcelos³ , Cristian Marcelo Villegas Lobos⁴ 
 Giancarla Aparecida Botelho Santos¹ 

1 - Universidade Federal de Lavras (UFLA), Lavras, Minas Gerais, Brasil

2 - Instituto de Matemática (INMA), Universidade Federal de Mato Grosso do Sul (UFMS), Campo Grande, Mato Grosso do Sul, Brasil

3 - Universidade Federal de São Paulo (UNIFESP), São José dos Campos, São Paulo, Brasil

4 - Universidade de São Paulo (USP), Piracicaba, São Paulo, Brasil

RESUMO

In 2019, external causes accounted for over ten percent of all reported incidents in Brazil, and 9% of global annual deaths are related to injuries, with 90% occurring in low- and middle-income countries. First aid training can significantly reduce hospitalizations and morbidity rates, making it an essential part of emergency response. This study aimed to implement a first responder program and evaluate its impact on high school students' knowledge in Lavras, Minas Gerais, Brazil. The course included five hours of theoretical and practical instruction and was conducted in five public and two private schools. A pre- and posttest examination was designed to measure learning outcomes. The data were analyzed using R software, version 3.6.0, with p-values less than 0.05 considered statistically significant. Graphical analyses were performed using ggplot2, and the multcomp package was used to compare schools. In total, 773 students completed the pretest, and 765 met the posttest inclusion criteria. Public schools showed improved results across all areas, except for a question about bleeding. Both private schools showed significant improvements. The increase in correct answers between phases suggests the course effectively improved knowledge, although further focus on bleeding topics and long-term retention may be necessary.

Keywords: School Health; First Aid; Basic Life Support; Underdispersion; Nonparametric test.

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Correspondência

Denize Palmito dos Santos
 Instituto de Matemática (INMA)
 Universidade Federal de Mato Grosso do Sul (UFMS), Cidade Universitária
 Caixa Postal 549, CEP: 79070-900
 Campo Grande-MS, Brasil.
 E-mail: denize.palmito@ufms.br

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INTRODUÇÃO

According to the World Health Organization (WHO) latest report, nine percent of the world's annual deaths, more than five million lives lost¹, are related to injuries. Among those, road traffic injuries, self-harm and falls are estimated to become part of the twenty leading causes of death until 2030, almost five percent of the worldwide deaths². Furthermore, injuries are responsible for six percent of the total years lived with disability, and also results in other problems besides the physical ones¹⁻⁵.

However, like any other health problem, the burden of this global concern is unequally distributed: while the deaths caused by injuries are declining in the high-income countries, the low- and middle-income one's accounts for ninety percent of the total deaths¹⁻². This trend tends to exacerbate with the demographic transition and urbanization of the global south countries, which lacks infrastructure and is especially affected by social disparity consequences, such as violence and accidents^{1,5,7}. At the same time, regardless of being the most affected, evidence-based interventions are under-developed in these countries⁷. Even into a country, injuries show a social gradient, affecting the poorer and minorities more than the general population^{1,7}.

Brazil, as an upper-middle income country, suffers an enormous burden of injuries and violence⁷. In 2019, road traffic injuries, suicides and falls accounted, together, for five percent of the notified causes of death while external causes, in general, accounted for more than ten percent of the total notifications which corresponds to 142.800 lives⁸. Furthermore, interpersonal violence is the leading cause of death and Years Lived with Disabilities (YLD) and road injuries remain in the sixth position⁷ with higher incidence among young brown males, already a neglected group⁹. Despite having a National Policy for Emergency¹⁰ integrated into its Unified Health System (UHS), the program does not cover the entire Brazilian population that leads to regional disparities and suffers from the absence of a real network organization¹¹.

In view of this demand, first aid training is a crucial component of an emergency response to this problem once it can reduce hospitalizations, morbidity and mortality with a myriad of cost-effective educational interventions, such as traditional classroom or even online courses, public campaigns and focused events¹². In this sense, schools, as a place of knowledge sharing and building, can play a vital role in training lay people to pass on initial help and information on how to access the emergency system^{12,13}.

More specifically in Lavras, a city with a population of one hundred and five thousand people in the southeast of Brazil, a group from the Health Sciences School from the Federal University of Lavras implemented, during the 2017-2019 triennium, interventions in public and private high schools, aiming the propagation of first aid techniques and Basic Life Support (BLS), based on the American Heart

Association (AHA)/American Red Cross (ARC) guidelines¹². The work searched to elaborate and to implement the first responder program and to measure its impact on the attendants' knowledge.

In health studies, it is common to use discrete nature data and these, in turn, may present overdispersion/underdispersion. This fact may be due to several factors, such as variability in experimental materials, excess of zeros, correlated issues, and others. Data with these characteristics generally use the quasi-likelihood approach introduced by Wedderburn¹⁴. The most common models for incorporating overdispersion are the quasi-binomial and quasi-Poisson models.

Several studies use the quasi-binomial model to analyze data of this nature. Ran et al.¹⁵ estimated the association between the lethality rates of COVID-19 and as particulate material (PM) bonds. Valentino et al.¹⁶ identified the exposure factors that can occur in the probability of hypertension in a Chilean population. Still with this approach, Hendrickson et al.¹⁷ evaluated the effect of the timing of initial debridement and wound excision in open tibia fractures.

In that regard, the main goal of this study was to identify possible improvements in the learning of first aid techniques in the environment of public and private schools by Brazilian high school students in Lavras, Minas Gerais.

MATERIALS AND METHODS

The course was developed and implemented by a group of five students, from medicine, nutrition, physical education and biology, along with their mentor, a physiologist and physiotherapist trained in BLS (Basic Life Support). It was based on WHO (World Health Organization), AHA (American Heart Association), IFRC (International Federation of Red Cross) and Red Crescent Societies¹⁸ and The Ministry of Health of Brazil previous interventions and studies¹⁹.

Study Development

The members have been trained in accordance with the latest AHA/ARC (American Red Cross) guidelines by a local firefighter and local nurses, including two who work in the Mobile Emergency Care Service (MECS) and are trained in BLS, ACLS (Advanced Cardiac Life Support) and ATCN (Advanced Trauma Care for Nurses) and one in primary care trained in BLS, to ensure both the correct execution of the techniques and the assessment of professional perceptions about the local context. School principals and educators were also contacted to suggest topics they considered important in each district²⁰.

The course material is written with ten main learning objectives in mind, including scene assessment, help request, vital signs, cardiopulmonary resuscitation maneuver, seizures, bleeding, Heimlich maneuver, bone injuries, foreign body airway obstruction (FBAO) and patient immobilization and

transport. Topics such as thermal burns, snake bites and poison ingestion were also taught according to the students' interest and self-report. The classes consisted of seven sessions of theoretical and practical content related to the respective themes, and lasted approximately five hours, taught over a day. Each session was conducted by at least two members, and simulations, presentation slides and music took place as learning a tool²¹. The Faculty of Health Sciences also provided CPR (Cardiopulmonary resuscitation) mannequins, immobilization splints and bondages, and an automated external defibrillator simulator. Project members also made splints from accessible materials, such as newspapers and sticks, to simulate an everyday situation. Some practices required interaction between classmates, encouraging the students to engage in the learning process with someone they are emotionally attached to.

A total of 15 schools were contacted by the group, including all the 8 public high schools and 6 private high schools in Lavras as well as 1 public school in Ribeirão Vermelho, a surrounding city. Of these, only 7 public schools were available for the project, including the Ribeirão Vermelho one, and 2 private schools. However, the school in the surrounding city and one of the public schools in Lavras were the object of a parallel project led by a member, with a different approach and pedagogical methodology²². Approval was obtained from the Federal University of Lavras Human Research Ethics Committee of the Federal University of Lavras and informed consent from the participants and their parents or guardians was collected by the schools prior to the study.

To assess the learning of high school students, a criteria-based examination was designed. It was applied before (pretest) and after (posttest) the classes, to determine, respectively, prior knowledge on the subject and the improvement or impact of the program. As seen in Table 1 (supplementary material), it was composed of nine multiple-choice questions, each with four alternatives, to measure the central themes of the course. The pretests were applied on the same day of class, according to the availability of each school. The posttests were always applied within a week after the classes took place and were answered by the students who attended the classes, according to the attendance form of the school researchers. In addition, data were interpreted quantitatively with a collective approach rather than individually, since sociodemographic data were not collected, highlighting the general results of the intervention by school.

Statistical analysis

As the sample size related to data from public and private schools had different sizes, two different statistical methods were considered to analyze each of the samples. The analysis of public schools was performed based on a statistical model of quasi-likelihood and for private schools a non-parametric test was applied. The data were analyzed

using the free software R version 3.6.0²⁴ and in all statistical tests a significance level of 5% ($p < 0.05$) was adopted. The graphical analyses were performed in the ggplot2 package²⁵ and the function glht from the multcomp package²⁶ was used to compare schools using contrasts. Finally, to verify the goodness of fit, the simulated envelopes are available in the hnp package²⁷.

Public Schools

Data described as proportions of successes (number of correct answers) are usually evaluated based on a binomial model. Therefore, the limits of the values of the response variable are defined between 0 and 1. In this way, for our data set we assume that the response variable (number of correct answers) follows a binomial distribution, that is, $Y_{ijk} \sim \text{Binomial}(m_{ijk}, \pi_{ijk})$ with m_{ijk} the number of students and π_{ijk} the proportion of correct answers from the i -th school, from the j -th type of question in the k -th phase, respectively.

Supposing that,

$$\pi_{ijk} = \frac{\exp\{\mu + \alpha_i + \beta_j + \gamma_k + (\beta\gamma)_{jk}\}}{1 + \exp\{\mu + \alpha_i + \beta_j + \gamma_k + (\beta\gamma)_{jk}\}}$$

$$i = 1, 2, \dots, 5$$

$$j = 1, 2, \dots, 9$$

$$k = 1, 2$$

- μ represents the overall average
- α_i is the effect of the i -th school
- β_j is the effect of the j -th question type
- γ_k is the effect of the k -th phase (pretest or posttest)
- $(\beta\gamma)_{jk}$ is the effect of the jk -th interaction between type of question and phase.

It's possible to show that,

$$E[Y_{ijk}] = m_{ijk}\pi_{ijk} \text{ and } Var[Y_{ijk}] = m_{ijk}\pi_{ijk}(1 - \pi_{ijk}). \quad (1)$$

The data set analyzed in this work showed an underdispersion, that is, the data variability is smaller than the expected value. Thus, the parameter estimation technique called quasi-likelihood proposed by Wedderburn¹⁵, considering a quasi-binomial model, where a specification for the mean and variance, which are the first two moments of the distribution, was used. Therefore, for the binomial model the variance presented in equation (1) is replaced by

$$Var[Y_{ijk}] = \varphi m_{ijk}\pi_{ijk}(1 - \pi_{ijk}) \quad (2)$$

where, φ is unknown and corresponds to the overdispersion parameter.

Private Schools

Samples of questionnaires applied to students who participated in pre- and posttests in private schools were very small. Furthermore, there is no information about their distributions, so the Wilcoxon-Mann-Whitney non-parametric test was applied to verify if the distributions were equal in location, that is, the goal was to compare two populations (pretest and posttest) and analyze whether the median of the two samples were equal.

RESULTS

In total, 773 attendees responded to the pretest, with 71.8% from the public network and 28% from the private one. However, dropouts were found in the posttest, as there was a total of 765 attendees attending the inclusion criteria for this phase of the research, with a mean age of 16,6 years.

Public Schools

The Figure 1 presents a descriptive analysis of the proportion of correct answers to the questions applied in the public and private schools in the pretest and in the posttest.

The boxplots offer the empiric distribution of the values and the outline in the rectangles indicates the median value. In general, it is possible to notice higher proportions of correct answers in the posttest questionnaire. Note that in public school B this growth was less pronounced than in the other schools analyzed.

Table 1 presents the descriptive measures of the mean and standard deviation of the correct answer ratio considering the different types of questions applied in the questionnaires. It is possible to observe that, with the exception of question 6, all levels presented the highest means of the proportions of the posttest, evidencing a possible increase in the number of questions answered correctly in the at this stage. In the vast majority of cases, it is possible to note that in the posttest there is a slight increase in data variability, indicating a small fluctuation in relation to the proportion of correct answers. This result is expected, since most students who participated in the pretest did not have much knowledge related to immediate care required in first aid care. Because of this, there is greater uniformity in the pretest (smaller variance) than in the posttest (larger variance).

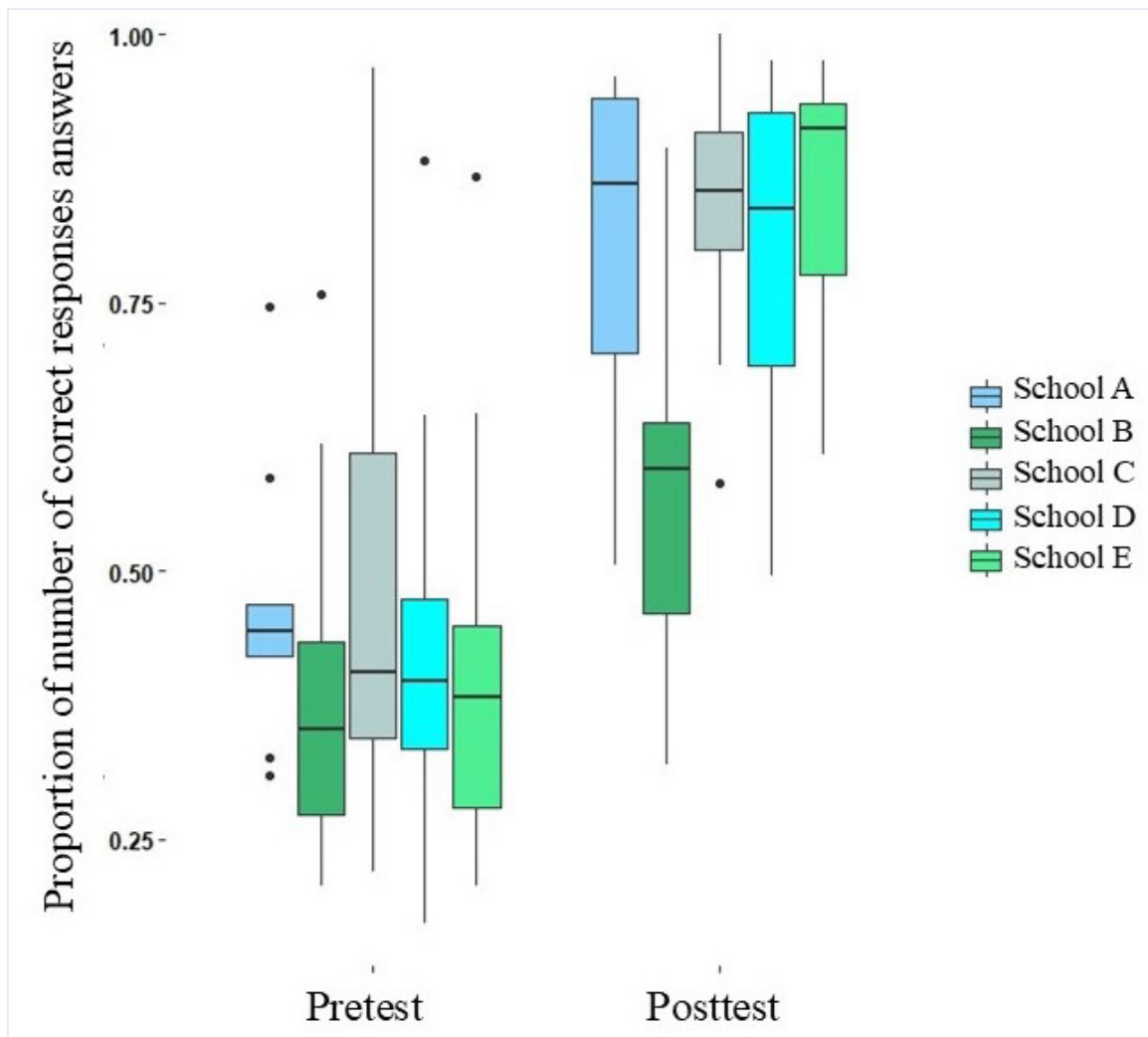


Figure 1. Boxplots of the proportion of correct answers in the pretest and in the posttest applied to five public schools.

Table 1. Mean (standard deviation in parentheses) values of the proportion of correct answers separated by test (Pre and Post) related to the types of questions to five public schools

	Pretest	Posttest
Question 1 (Seizures)	0.415(0.021)	0.927(0.084)
Question 2 (Initial Measures)	0.265 (0.035)	0.811(0.145)
Question 3 (FBAO)	0.844 (0.093)	0.950(0.032)
Question 4 (Fracture)	0.336 (0.063)	0.733 (0.198)
Question 5 (Rescue)	0.383 (0.041)	0.790 (0.100)
Question 6 (Bleeding)	0.643 (0.04)	0.596 (0.141)
Question 7 (Vital signs)	0.401 (0.05)	0.662 (0.158)
Question 8 (Fainting)	0.468 (0.09)	0.874 (0.133)
Question 9 (CPR)	0.228 (0.05)	0.602 (0.162)

Note: FBAO = airway obstruction by a foreign body.

Figure 2 shows the ratio of the mean to the variance considering the explanatory variables schools and phases. Note that the points are all located below the diagonal line, indicating that in this dataset there are signs of underdispersion, once the sample variance is less than the sample mean. Underdispersion occurs when data exhibits less variation than expected. Thus, there are signs that the occurrences related to the number of correct answers of the applied questions are more uniformly among public school students.

Table 2 (supplementary material) shows the estimates Standard Errors (SEs) and p-values of the quasi-binomial model parameters. Based on this table, it can be seen that School B differs significantly from School A at the 5% level, and from Figure 1 it can be seen that School B presented the smallest proportion related to the number of correct answers. The other levels do not show a significant difference when compared to School A. Given this information, a multiple comparison test was applied using contrasts to verify the differences between the schools. Figure 3 shows that Schools A, C, D and E do not differ from each other and both differ from School B.

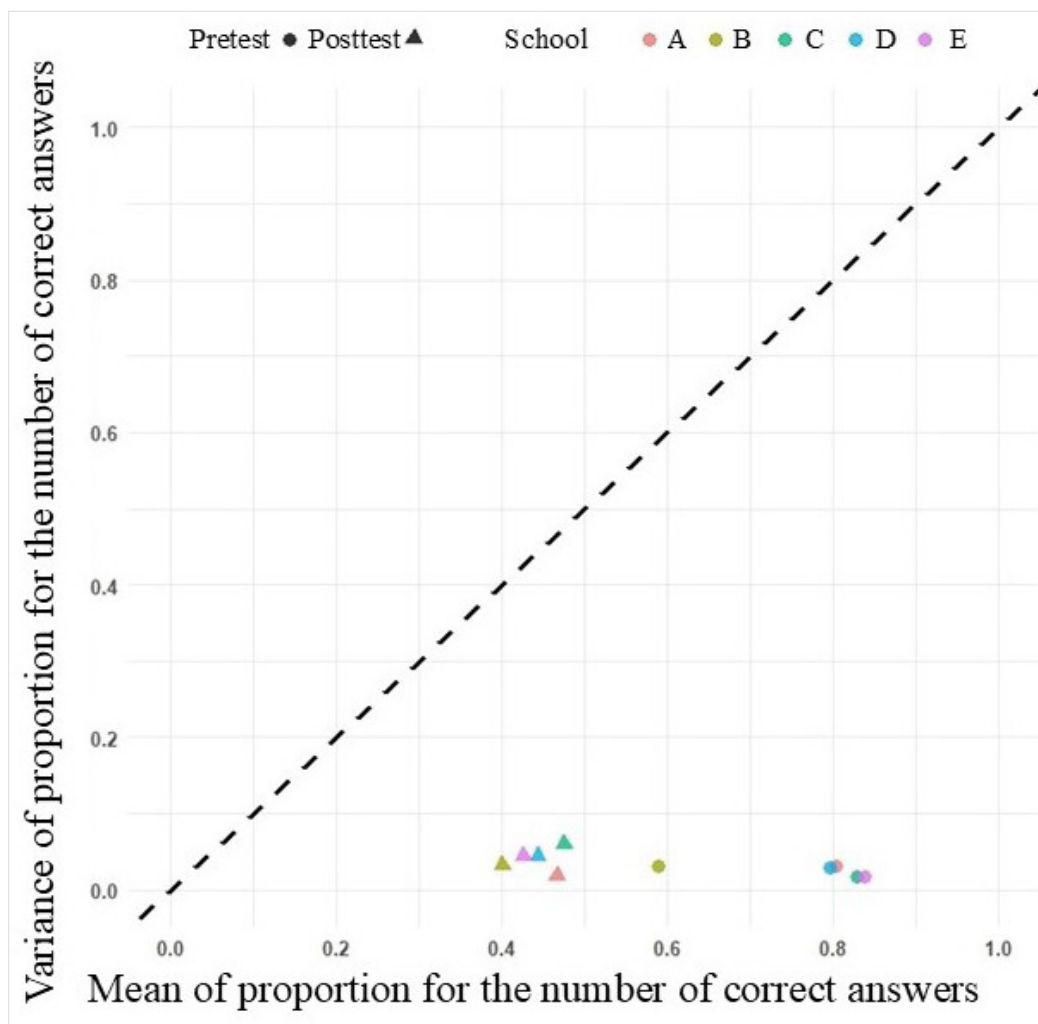


Figure 2. Graph of the sample's variance in relation to the average of each combination of the levels of the explanatory variables schools and phase to five public schools.

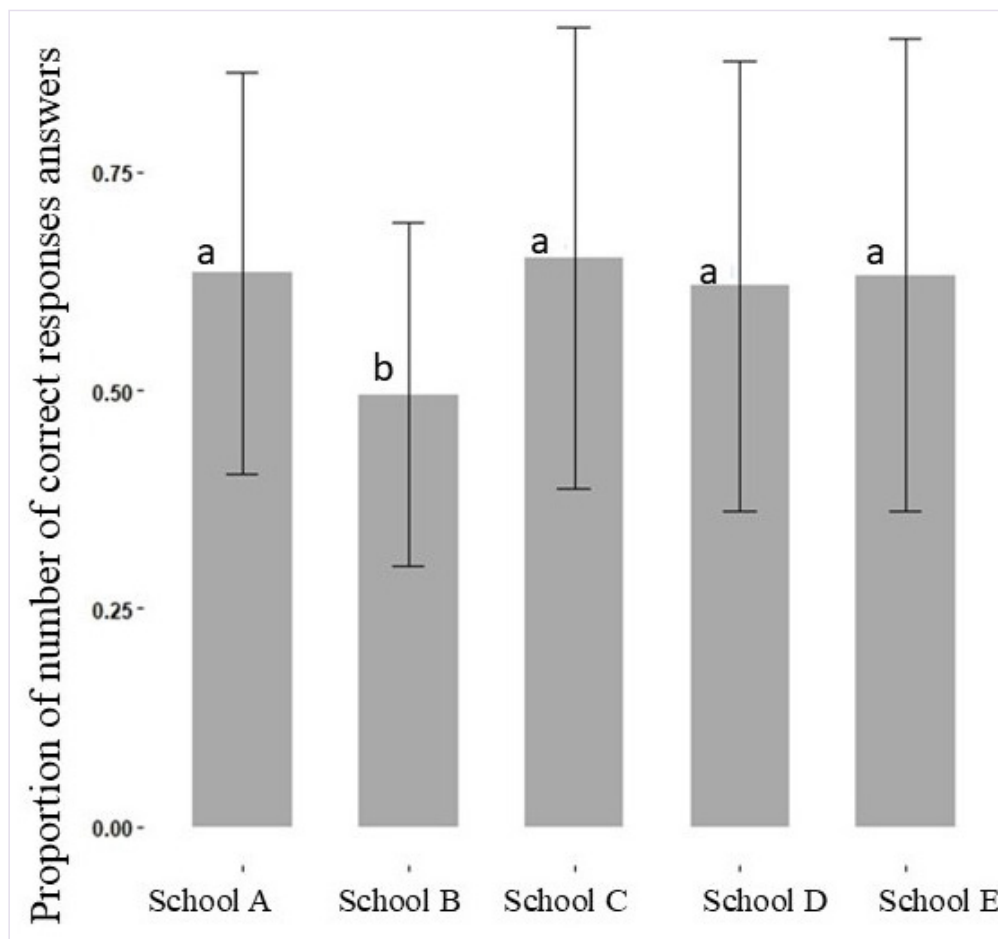


Figure 3. Average and \pm standard deviation of the proportion of correct answers regarding the questionnaires applied in the public school system.

Note: The lower case letters indicate the significant differences between schools.

Also in relation to Table 2 (supplementary material), some parameters associated with the interaction effect question \times phase (pre- and posttest) are significant. This means that the effects related to the types of questions depend on the application phase of the questionnaires; therefore, the interpretation of these factors will be limited to parameters that are related to the interaction effects.

The score from the posttest question 4 (Fracture) presents a significant difference when compared to posttest question 1 (seizures), with a lower number of correct answers. The same behavior was observed in the comparison between the number of correct answers in question 1 and the scores of questions 6, 7 and 9, related to bleeding, vital signs and CPR, respectively. It is possible to observe in Table 1 that the proportion of correct answers related to question 3 (choking) is higher than in question 1 (seizures), indicating greater knowledge of first aid related to airway obstruction by a foreign body than in relation to seizure. In the questions 2, 5 and 8 (Initial Measures, Rescue and Fainting) there was no significant difference when compared to question 1, indicating that, in average, students have the same knowledge base in these areas.

Figure 4 shows the hnp plot Moral et al.²⁶ for residual analysis. Note that there is evidence of a good fit, as all points are contained within the region bounded by confidence plot. Thus, the regression model used is a plausible model to explain the proportion of correct answers data for the first aid questions that were applied to public school students.

Private Schools

Figure 5 shows the boxplot for the proportions of correct answers applied to the questionnaires in private schools. Note that in both schools there was an increase in values proportion in the posttest indicating a greater number of correct answers among the attendants in this phase. In addition, it is possible to notice a greater variability in the proportion of correct answers questionnaires applied in the pretest and most responses had a lower proportion to 0.75. Based on the Wilcoxon-Mann-Whitney test, it was found that in both schools, the individuals presented a p -value < 0.05 , that is, the mean value referring to the data proportion of the correct answers data is significantly different in the pretest and in the posttest.

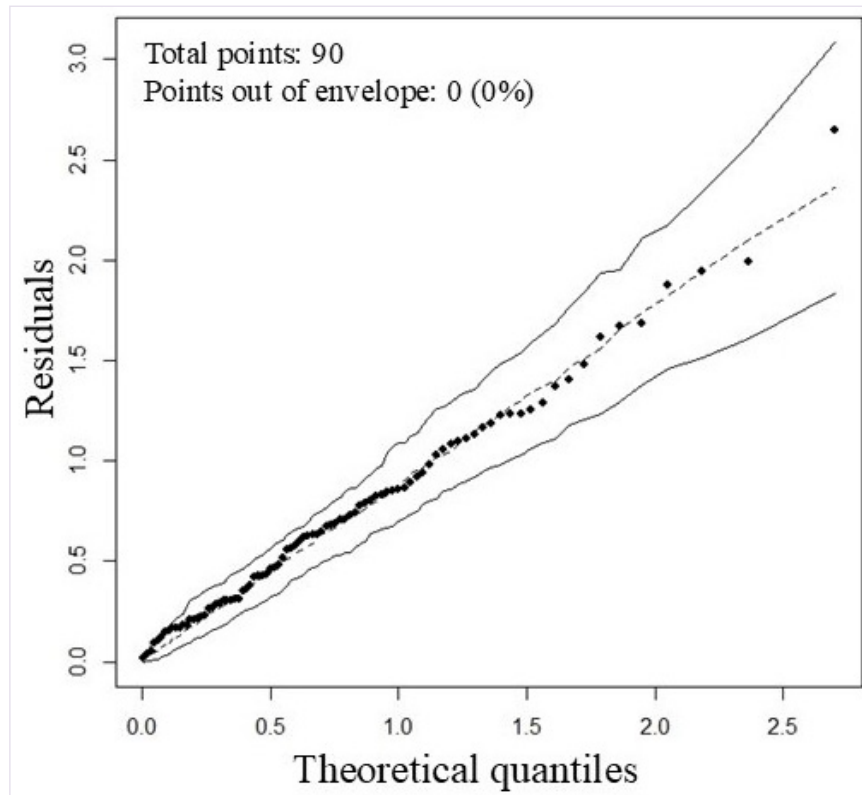


Figure 4. Half-normal plots with simulated envelopes for the deviance residuals from the quasi-binomial model fitted to the proportion data (equation3) to five public schools.

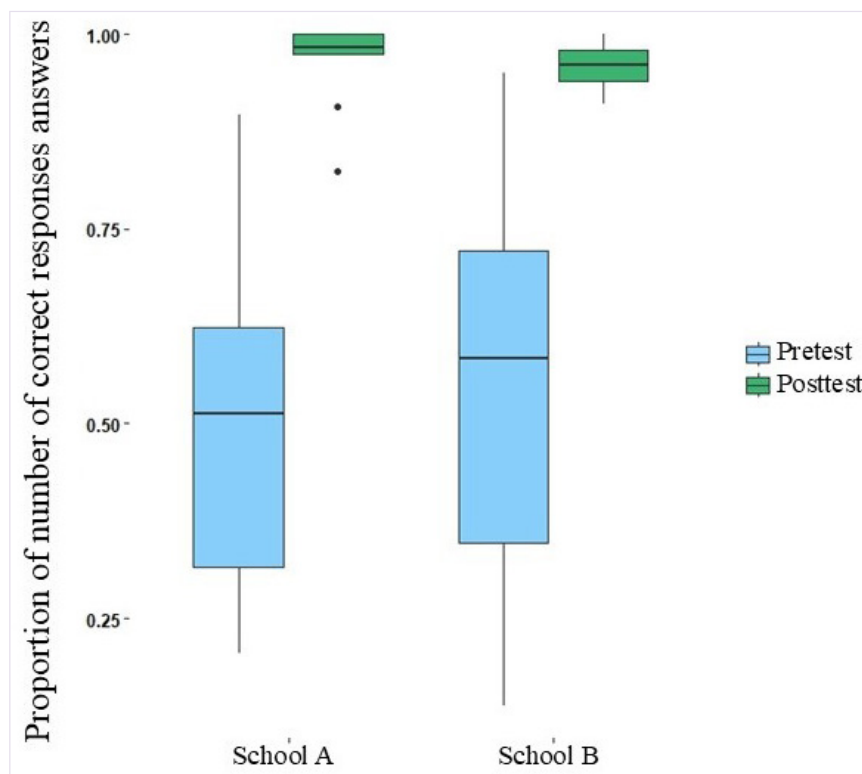


Figure 5. Boxplots of the proportion of correct answers in the pretest and in the posttest applied in two private schools.

DISCUSSION

While first aid and BLS are important initial steps to mitigate worsening and fatal injury outcomes, it is estimated that

the numbers of lives saved by lay spectators is suboptimal²⁷, mainly due to the absence of the initial link in the life support chain. A review²⁸ of studies carried out in 22 different countries found that about 50% of the attendants in first aid

training courses had previous contact with the material in the last 5 years; however, selection bias and inconsistency in the data suggest that the proportion of trained lay people in the population is much smaller, contrasting with the importance of this knowledge for a healthier society.

The latest official data on accidents in the age group of 10 to 19 years collected by the Ministry of Health of Brazil indicates a prevalence of 12,348 victims of accidents and violence per year²⁹. As proposed by systematic reviews^{30,31}, first aid training programs, in special those targeting adolescents, have generally been associated with beneficial outcomes. Lengthy of at least 3 hours, teaching materials such as mannequins, active demonstrations and context specific themes, as presented in this study, were some of the aspects of an age-appropriate intervention for teens³⁰. Besides, topics such as calling for help, suffocation, bleeding, unconsciousness and CPR should be essential components of the course material³¹.

According to the results, the overall scores increased between the pre- and posttest indicates a visible improvement in knowledge about targeted first aid and BLS topics and short-term retention of the course content among public and private school students. Most of the test questions had a higher proportion of right answers and an acceptable increase in the number of correct answers between pre- and posttest. Likewise, most public schools showed a marked progress in the posttest, and the performance of private schools indicated the positive impact of the course since the mean value of correct answers increased significantly after the conducting classes.

Public Schools

Regarding the pretest, question 3 (Foreign Body Airway Obstruction) had the highest average score, demonstrating that it was the most established among the course topics, while questions 2 (initial measures) and 9 (CPR) had the lowest ones, which is understandable since the need of using these techniques is less recurrent based on the students' reality.

Posttest results reinforce some previous findings, as question 3 remains with a significantly higher average of correct answers, when compared to question 1 (seizures) in the posttest. The predominance⁹ and public awareness of choking, together with the frequency of self-reported cases from the attendants during the course, are some of the possible explanations. The overall score of questions 4, 6, and 7 were significantly lower than question 9 mean score in the second phase, correlating with possible less knowledge about these topics than in relation to seizures. On the other hand, questions 2, 5 and 8 did not show significant differences in relation to question 1. The direct link between the themes CPR and vital signs, as well as bleeding and fractures, can clarify the results after the interference, as they crossbreed at many points¹².

Question 6 had an unexpected performance when compared to question 1: not only it did not have distinguished

improvement in the mean-score proportion but it also had worsened. As local studies show, bleeding is a theme shrouded in non-scientific knowledge and techniques³², as some of the questions answers themselves tried to capture. Nevertheless, self-reported situations were brought by the attendants about unusual materials and methods used to stop bleedings, such as toothpaste, flour and baby powder. But, instead of a progress after the classes and practices, the results went to the opposite direction, pointing out deficits in the program, whether in the issue itself or in teaching, which should be adjusted in future actions. The course extension, of 5 hours, can also hinder the learning process of the last subjects, as is the case of fractures and bleedings in the trauma sector of the course³⁰.

With regard to public schools as a whole, schools A, C, D and E had similar behavior, both in terms of the mean value for correct answers in the posttest and the proportion of improvement between the pre- and the posttest. This sameness is probably related to a diversity of factors that were previously associated with the learning process in the literature, such as structural similarities, number of students per classroom and participation of the school teachers in the course^{30,33}. School B, on the other hand, performed worse when compared to other schools in its group. Despite the structural similarities and little or no difference in the ratio of individuals per classroom, in school B, the educators did not keep up with their students in both practical and theoretical classes^{30,34}. As reported by the researchers, besides constantly questioning first aid techniques, always referring to common sense or alternative techniques not supported by the scientific literature³², the high school students from B seemed less interested in the content than the other groups, despite the use of the same active methodologies, which made it difficult to clarify the myths surrounding the discussed topics. This opens up an interesting matter for a suitable future investigation, in the area, by health researchers from anthropological and educational masteries.

Private Schools

With regard to private schools, the meaningful increase in the average proportion of correct answers in the posttest suggests that the course can efficiently increase the total knowledge of the subjects taught and appraised. In both schools, researchers found that the attendants were proactive and the teachers were always in class, stimulating high school students and engaged in practices³⁴.

Brazilian secondary educational system involves the upper secondary education, mainly targeting teens aged 15 to 18 years³⁵. The financing of these public schools is a shared responsibility of the federation, the state and the county, but the administration of resources is the responsibility of each region. In 2016, the government expenses on secondary education were US\$3,800 per student per year, less than half OECD (Organization for Economic Co-operation and

Development) average³⁵. Despite the continuous students' increase, teachers' wage remains low comparing to the OECD one³⁵. As a very unequal country, Brazil shows a huge gap between the education offered in its public system and the quality of the private education³⁶. In this regard, the smaller the size of the classes, the better the structure, the teachers' previous experience and the continuing education that are linked to a general better overall result in the learning process of private students when compared to public ones with similar performances^{35,36}.

Some contrasts between public and private schools were perceived during the course appliance. For example, fewer students per classroom in private schools seemed to favor the appliance of the course. In the context of learning, it was noticed that students from different types of institutions have the same ability to gain applied knowledge³⁴. However, the better physical, pedagogical and organizational structure of the private environment³⁶, added to the smaller number of students, led to an imprecise comparison between the two different school groups, since it would be difficult to seclude which factors were truly responsible for the differences found in the results and in which magnitude.

The study also shows some barriers, despite its overall positive results. The lack of individualized sociodemographic data resulted in a limited analysis to cross-school comparisons. Another barrier is the lack of a follow-up strategy, leading the study to focus only on short-term week-long knowledge retention. Future investigations should be carried out to ensure greater control over the influence of individual variables on the results, such as gender, age, socioeconomic status, previous training and long-term follow-up.

CONCLUSION

This study presents the development and implementation of a first aid course aimed at secondary education in the Brazilian city of Lavras, through the inclusion of methods from previous programs and local health assistance and education professional help. The overall improvement by subject between phases, aligned with the increase in average test between pre- and posttests for private and public schools demonstrates the course effectiveness in short-term knowledge retention. Although individual sociodemographic data gathering, the teaching and assessment of bleeding containment and the attendants' long-term follow-up to assess retention and the use of skills and knowledge should be improved in future course implementations. As the first link in the emergency care, lay rescuers are notably important in the alarming context of violence and injury in LMIC (Lower Middle-Income Country). Thus, interventions, such as those related, are potential palliative measures to help improve the population DALYs (Disability Adjusted Life Years) and life expectancy.

CONFLICTS OF INTEREST

TE, DS, CS, FT, JA, JV, GA and CV have no affiliations or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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ABSTRACT

Em 2019, causas externas foram responsáveis por mais de dez por cento de todos os incidentes relatados, no Brasil, e 9% das mortes anuais globais estavam relacionadas a ferimentos, com 90% ocorrendo em países de baixa e média renda. O treinamento em primeiros socorros pode reduzir significativamente as hospitalizações e as taxas de morbidade, tornando-se uma parte essencial da resposta a emergências. Este estudo teve como objetivo implementar um programa de primeiros socorros e avaliar seu impacto no conhecimento de alunos do ensino médio em Lavras, Minas Gerais, Brasil. O curso incluiu cinco horas de instrução teórica e prática e foi realizado em cinco escolas públicas e duas privadas. Um exame pré e pós-teste foi elaborado para medir os resultados da aprendizagem. Os dados foram analisados usando o software R, versão 3.6.0, com valores de p menores que 0,05 considerados estatisticamente significativos. As análises gráficas foram realizadas com o auxílio do ggplot2 e o pacote multcomp foi usado para comparar escolas. No total, 773 alunos concluíram o pré-teste e 765 atenderam aos critérios de inclusão do pós-teste. As escolas públicas apresentaram resultados aprimorados em todas as áreas, exceto em uma questão sobre sangramento. Ambas as escolas particulares mostraram melhorias significativas. O aumento de respostas corretas entre as fases sugere que o curso efetivamente melhorou o conhecimento, embora um foco maior em tópicos sangrentos e retenção de longo prazo possa ser necessário.

Palavras-chave: Saúde Escolar; Primeiro socorro; Suporte Básico de Vida; Subdispersão; Teste não paramétrico.

RESUMEN

En 2019, las causas externas fueron responsables de más del diez por ciento de todos los incidentes reportados en Brasil, y el 9% de las muertes anuales mundiales estuvieron relacionadas con lesiones, y el 90% ocurrieron en países de ingresos bajos y medianos. La capacitación en primeros auxilios puede reducir significativamente las hospitalizaciones y las tasas de morbilidad, lo que la convierte en una parte esencial de la respuesta de emergencia. Este estudio tuvo como objetivo implementar un programa de primeros auxilios y evaluar su impacto en el conocimiento de estudiantes de secundaria en Lavras, Minas Gerais, Brasil. El curso incluyó cinco horas de instrucción teórica y práctica y se llevó a cabo en cinco escuelas públicas y dos privadas. Se diseñó un examen previo y posterior a la prueba para medir los resultados del aprendizaje. Los datos se analizaron utilizando el software R, versión 3.6.0, considerándose estadísticamente significativos los valores de p inferiores a 0,05. Los análisis gráficos se realizaron con la ayuda de ggplot2 y se utilizó el paquete multcomp para comparar escuelas. En total, 773 estudiantes completaron la prueba previa y 765 cumplieron los criterios de inclusión de la prueba posterior. Las escuelas públicas mostraron mejores resultados en todas las áreas excepto en una pregunta sobre sangrado. Ambas escuelas privadas mostraron mejoras significativas. El aumento de respuestas correctas en las distintas fases sugiere que el curso efectivamente mejoró el conocimiento, aunque puede ser necesario un mayor enfoque en temas candentes y la retención a largo plazo.

Palabras clave: Salud Escolar; Primeros auxilios; Soporte Vital Básico; Subdispersión; Prueba no paramétrica.

Supplementary Material

Table S1. Questionnaire Applied as Pre- and Posttest Instrument. Bold = Correct Answer.

Question	Answer
1. In front of a case of seizure, what should we do?	a) Hold the victim's head to protect it and remove objects that could injure it and place it in a lateral position; b) Wait for the crisis to pass without doing anything; c) Hold the victim's head and unroll the victim's tongue using your fingers; d) I don't know;
2. When you witness an accident victim, what steps do you take?	a) I stay away like everyone else; b) I look at the victim and I call for the specialized help; c) I go to the victim and try to see if she is awake, touch the victim trying to get her up and call the emergency service; d) I look at the place where the victim is, I reach the victim and kneel on his side, analyze the victim's vital signs, call the emergency service and then start the first aid techniques;
3. If a person chokes on food or an object, what should we do?	a) Punching the person's back; b) Give water to that person; c) Encourage the person to cough and hug them from behind, pressing 4 fingers above their navel, making a movement with closed fist inward and upward; d) Turn the person upside down;
4. If a person falls and suffers a fracture, how should we proceed?	a) Move the broken limb and place it in line with the victims body even if this action generates a lot of pain; b) Do not move the fractured limb and call the emergency medical services; c) Use a splint or a resistant surface (newspaper, wood, cardboard) and also a band, immobilize the place where the fracture occurred and also the joints close to this fracture; d) Pass the band only where the fracture occurred, without immobilization, and apply saline solution if possible.
5. If the victim does not show vital signs, what should we do?	a) Call for rescue (Military Firefighter or Emergency Service) b) Call for rescue and start the Cardio Pulmonary Resuscitation (CPR) maneuver; c) Give the victim alcohol to sniff; d) Call for rescue and leave the scene;
6. What should we do about wounds and bleedings?	a) Wash the wound using alcohol and bandage; b) Put coffee powder or sugar to stop the bleeding; c) Use any piece of cloth to stop the bleeding; d) Wash with water or saline solution, use gauze or a clean cloth to contain the bleeding with a bandage;
7. Do you know how to verify someone's vital signs? Choose the correct technique	a) Look for a blood pressure monitor device to measure the victim's pressure; b) Check if the victim breathes by visualizing if the chest moves; c) Place the ear on the victim's chest to check for heartbeat; d) Look for a mirror to analyze if the victim is breathing;
8. In cases of fainting, how should we proceed?	a) Give the person alcohol to sniff; b) Do not move the person and when he is waking up give him a glass of water; c) Check the victim's vital signs and place his legs in a position higher than his heart; d) I don't know;
9. How should the CPR maneuver be performed?	a) Lay the person down on a mattress and squeeze their chest very tightly; b) Lay the person down on a hard surface and press down on the heart with little force and slowly, to not hurt them; c) Lay the person down on a soft surface, press two fingers above the xiphoid process, at a speed of 100 times per minute, making two mouth-to-mouth breaths every 30 compressions; d) Lay the person down on a hard surface, press two fingers above the xiphoid process, at a speed of 100 to 120 times per minute, making two mouth-to-mouth breaths (if you have protection) every 30 compressions;

Table S2. Results of the quasi-binomial logistic regression model Fitted to the proportion data to five public schools.

Effects	Parameter	Estimate	SE	p-value
Intercept	μ	-0.156	0.213	0.468
School B	α_2	-0.736	0.151	<0.001
School C	α_3	0.090	0.191	0.637
School D	α_4	-0.063	0.162	0.695
School E	α_5	-0.020	0.153	0.892
Question 2 (Initial Measures)	β_2	-0.684	0.285	0.019
Question 3 (FBAO)	β_3	1.939	0.313	<0.001
Question 4 (Fracture)	β_4	-0.386	0.276	0.166
Question 5 (Rescue)	β_5	-0.153	0.271	0.574
Question 6 (Bleeding)	β_6	0.903	0.273	0.001
Question 7 (Vital signs)	β_7	-0.060	0.270	0.822
Question 8 (Fainting)	β_8	0.135	0.268	0.616
Question 9 (CPR)	β_9	-0.890	0.293	0.003
Posttest	γ_2	2.738	0.384	<0.001
Question 2: Posttest	$(\beta\gamma)_{22}$	-0.326	0.497	0.513
Question 3: Posttest	$(\beta\gamma)_{32}$	-1.393	0.620	0.028
Question 4: Posttest	$(\beta\gamma)_{42}$	-0.986	0.482	0.044
Question 5: Posttest	$(\beta\gamma)_{52}$	-0.968	0.486	0.050
Question 6: Posttest	$(\beta\gamma)_{62}$	-3.00	0.472	<0.001
Question 7: Posttest	$(\beta\gamma)_{72}$	-1.649	0.473	<0.001
Question 8: Posttest	$(\beta\gamma)_{82}$	-0.659	0.507	0.198
Question 9: Posttest	$(\beta\gamma)_{92}$	-1.172	0.483	0.018
	ϕ	4.809		