ORIGINAL ARTICLE

Effectiveness of Construction and Presentation of Physical models by First MBBS students as an active Learning tool in Physiology

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Background: Understanding Physiological concepts is the backbone of Medicine. Active learning strategies can strengthen this process. The aim of this study was to introduce Model construction and its presentation as a self-directed learning tool (SDL) for the subject of Physiology.
Method: The 2nd semester, 1st MBBS students Batch 2021-2022 actively worked in groups to construct physical models. Outcome of the educational intervention was calculated through post test scores, assessment of the models by judges, and student feedback regarding the SDL activity of model construction and presentation.
Results: The comparison between scores for pre-test (8.1 ± 0.8) and post-test (12.8 ± 2.6) taken at the end showed that there was a statistically significant difference ($p<0.05$) in the scores. Evaluation of the model showed that groups scored well for all criteria except in their ability to answer queries. Students strongly supported Competitiveness (87%) and group discussions (79%). Some agreed that this activity was time consuming and tiring (45%).
Conclusion: Application of a Physiological concept in form of case scenarios acted as a trigger hence the search for answers initially generated interest and curiosity. The active engagement learning strategy resulted in knowledge gain as evidenced by student's performance in the post test and their ability to represent information on a physical model. Conventional teaching can be accompanied by similar strategies which are realistic, assure student participation and desirable learning outcomes.

Keywords: Self-directed learning, Active learning, Physical model, Case scenario

فعالية بناء وعرض النماذج الفيزيائية من قبل طلاب MBBS الأول كأداة تعليمية نشطة في علم وظائف الأعضاء

الخلفية: فهم المفاهيم الفسيولوجية هو العمود الفقري للطب. يمكن أن تعزز استراتيجيات التعلم النشط هذه العملية. كان الهدف من هذه الدراسة هو تقديم بناء النموذج وعرضه كأداة تعليمية ذاتية التوجيه لموضوع علم وظائف الأعضاء.
الطريقة: في الفصل الدراسي الثاني ، عمل طلاب MBBS الأول دفعة 2021-2022 بنشاط في مجموعات لبناء نماذج مادية. تم حساب نتيجة التدخل التعليمي من خلال درجات الاختبار اللاحق ، وتقييم النماذج من قبل الحكام ، وتعليقات الطلاب فيما يتعلق بنشاط SDL لبناء النموذج والعرض التقديمي.
النتائج: أظهرت المقارنة بين درجات الاختبار القبلي (8.1 ± 0.8) والاختبار البعدي (12.8 ± 2.6) المأخوذة في النهاية أن هناك فرقًا ذا دلالة إحصائية ($p<0.05$) في الدرجات. أظهر تقييم النموذج أن المجموعات سجلت درجات جيدة لجميع المعايير باستثناء قدرتها على الإجابة على الاستفسارات. أيد الطلاب بقوة التنافسية (87٪) والمناقشات الجماعية (79٪). اتفق البعض على أن هذا النشاط كان مستهلكًا للوقت ومرهقًا(45٪).
الخلاصة: إن تطبيق المفهوم الفسيولوجي في شكل سيناريوهات حالة كان بمثابة محفز ومن ثم أدى البحث عن الإجابات إلى إثارة الاهتمام والفضول في البداية. أدت استراتيجية التعلم بالمشاركة النشطة إلى اكتساب المعرفة كما يتضح من أداء الطالب في الاختبار اللاحق وقدرته على تمثيل المعلومات على نموذج مادي. يمكن أن يكون التدريس التقليدي مصحوباً باستراتيجيات مماثلة واقعية ، وتضمن مشاركة الطلاب ونتائج التعلم المرغوبة.

الكلمات المفتاحية: التعلم الذاتي، التعلم النشط ، النموذج المادي ، سيناريو الحالة

فزیالوجی میں ایک فعال لرننگ ٹول کے طور پر ایم بی بی ایس کے پہلے طلباء کے ذریعہ جسمانی ماڈلز کی تعمیر اور پیش کرنے کی تاثیر

پس منظر: جسمانی تصورات کو سمجھنا طب کی ریڑھ کی ہڈی ہے۔ فعال سیکھنے کی حکمت عملی اس عمل کو مضبوط بنا سکتی ہے۔ اس مطالعے کا مقصد ماڈل کی تعمیر اور اس کی پیشکش کو فزیالوجی کے مضمون کے لیے خود ہدایت شدہ سیکھنے کے آلے کے طور پر متعارف کرانا تھا۔
طریقہ: nd2 سمسٹر، st MBBS1 طلباء بیچ 2021-2022 نے جسمانی ماڈلز بنانے کے لیے گروپوں میں فعال طور پر کام کیا۔ تعلیمی مداخلت کے نتائج کا شمار پوسٹ ٹیسٹ کے اسکورز، ججوں کے ذریعہ ماڈلز کی تشخیص، اور ماڈل کی تعمیر اور پیشکش کی SDL سرگرمی کے حوالے سے طلباء کے تاثرات کے ذریعے کیا گیا۔
نتائج: پری ٹیسٹ (8.1 ± 0.8) اور آخر میں لیے گئے ٹیسٹ کے بعد (12.8 ± 2.6) کے سکور کے درمیان موازنہ نے ظاہر کیا کہ اسکورز میں شماریاتی لحاظ سے اہم فرق ($p<0.05$) تھا۔ ماڈل کی تشخیص سے پتہ چلتا ہے کہ گروپوں نے سوالات کے جوابات دینے کی صلاحیت کے علاوہ تمام معیارات پر اچھا اسکور کیا۔ طلباء نے مسابقت (87%) اور گروپ ڈسکشن (79%) کی بھرپور حمایت کی۔ کچھ لوگوں نے اتفاق کیا کہ یہ سرگرمی وقت طلب اور تھکا دینے والی تھی (45%)۔
نتیجہ: صورت حال کی صورت میں جسمانی تصور کا اطلاق ایک محرک کے طور پر کام کرتا ہے لہذا جوابات کی تلاش نے ابتدائی طور پر دلچسپی اور تجسس پیدا کیا۔ فعال مشغولیت سیکھنے کی حکمت عملی کے نتیجے میں علم حاصل ہوا جیسا کہ پوسٹ ٹیسٹ میں طالب علم کی کارکردگی اور جسمانی ماڈل پر معلومات کی نمائندگی کرنے کی ان کی صلاحیت سے ظاہر ہوتا ہے۔ روایتی تدریس کے ساتھ ایسی ہی حکمت عملی بھی ہو سکتی ہے جو حقیقت پسندانہ ہیں، طلباء کی شرکت کو یقینی بناتی ہیں اور سیکھنے کے مطلوبہ نتائج حاصل کرتی ہیں۔

مطلوبہ الفاظ: سیلف ڈائریکٹڈ لرننگ، ایکٹو لرننگ، فزیکل ماڈل، کیس سیناریو

اثربخشی ساخت و ارائه مدل های فیزیکی توسط دانشجویان سال اول پزشکی به عنوان یک ابزار یادگیری فعال در فیزیولوژی

زمینه و هدف: درک مفاهیم فیزیولوژیکی، ستون فقرات پزشکی است. راهبردهای یادگیری فعال می تواند این فرآیند را تقویت کند. هدف از این مطالعه معرفی، ساخت مدل و ارائه آن به عنوان یک ابزار یادگیری خودراهبر (SDL) برای درس فیزیولوژی بود.
روش: ترم دوم، دانشجویان سال اول پزشکی سال 2021–2022 به طور فعال در گروه ها برای ساخت مدل های فیزیکی کار کردند. نتیجه مداخله آموزشی از طریق نمرات پس آزمون، ارزیابی مدل ها توسط داوران و بازخورد دانشجویان در مورد فعالیت SDL ساخت و ارائه مدل محاسبه شد.
یافته‌ها: مقایسه نمرات پیش‌آزمون (0/8 ± 8/1) و پس‌آزمون (2/6 ± 12/8) در پایان نشان داد که تفاوت آماری معنی‌داری ($p<0.05$) در نمرات وجود دارد. ارزیابی مدل نشان داد که گروه‌ها برای همه معیارها به جز توانایی پاسخگویی به پرسش‌ها امتیاز خوبی کسب کردند. دانشجویان به شدت از رقابت پذیری (87٪) و بحث گروهی (79٪) حمایت کردند. برخی موافق بودند که این فعالیت وقت گیر و خسته کننده بود (45 درصد).
نتیجه‌گیری: استفاده از مفهوم فیزیولوژیکی در قالب سناریوهای موردی به عنوان یک محرک عمل می‌کند، از این رو جستجوی پاسخ‌ها در ابتدا باعث ایجاد علاقه و کنجکاوی می‌شود. استراتژی یادگیری تعامل فعال منجر به کسب دانش می شود که توسط عملکرد دانشجو در پس آزمون و توانایی آنها برای ارائه اطلاعات در یک مدل فیزیکی مشهود است. آموزش متعارف می تواند با راهبردهای مشابهی همراه باشد که واقع بینانه هستند و مشارکت دانشجویان و نتایج یادگیری مطلوب را تضمین می کنند.

واژه‌های کلیدی: یادگیری خودراهبر، یادگیری فعال، مدل فیزیکی، سناریوی موردی

INTRODUCTION

Self-directed Active learning proposed by the Competency based medical education curriculum 2019, encourages critical thinking, problem solving, collaboration and focuses on logic and deduction rather than rote memorization. Active learning strategies such as model making, demonstrations, discussion, debates, games, and role play are suited for diverse type of learners having varied preferences as visual, aural, read-write or kinaesthetic (1). Construction of physical models by undergraduate students is one such strategy which employs active learning (2). Literature reports the use of models to explain complex ideas as well as promote logical reasoning and creativity (2,3). Arthur Guyton's philosophy of 'learning by doing' (1,4,5) is applicable to model construction. 'To teach is to learn twice' (6) so presenting the concepts depicted by the models can achieve meaningful learning (1). In preclinical sciences, the core physiological concepts need to be emphasized through problem solving and constructivism; therefore, physical models can be effective for this purpose. Commercial models may not be preferred, since simulators are less economical (4). Therefore the present researchers proposed to introduce construction of physical models by students themselves and its presentation as an active learning strategy since presenting the self-designed model including teaching and explaining is known to enhance learning and improve retaining ability. These researchers used case scenarios which depicted application of a Physiological concept, and the model construction was based on that respective concept or mechanism.

The aims of this study were:

1. To compare the pre-test and post-test scores of students prior to and after the model construction and presentation activity.
2. To analyse the Likert scale response score for student feedback.
3. To analyse the Model evaluation scores of the groups.

METHODS

Study design: Educational Interventional study

Setting: Department of Physiology, Shri Vasantrao Naik Government Medical College, Yavatmal, India

Selection and description of participants: Totally 110 students of first year MBBS in 2nd semester of Batch 2021-2022 volunteered to participate in the activity. Written informed consent was taken from these students. Activity was carried out in the 2nd semester .They were divided into five groups, each group had 22 students. All students who voluntarily consented for the study were assigned alphabets A, B, C, D, E in sequence .Students assigned alphabet A formed one group, similarly groups B,C, D, E were formed. Each group had one department faculty member as a facilitator.

Details of the activity: Instructions and sensitization on conduction of activity was done by facilitators. Each group was assigned for one topic in Physiology by chit method. The topics were on:

a) Vestibular apparatus function
b) Left ventricular function
c) Haemostatic mechanisms
d) Optic pathway
e) Mechanics of ventilation

Two strategies were implemented for Self-directed learning (SDL). The 1st strategy was the use of online resources. Here students framed their own learning objectives, searched the given topic using online material and finally gave a brief summary to the class. At the end of one week, a pre- test in the form of brief answer question Test of 20 marks comprising of 10 questions for each group on the respective topic was taken. The 2nd strategy involved Model making and its presentation. It comprised of four sessions.

The 1st session – Case based scenarios with questions on the assigned topic was given to each group , students framed their own learning objectives, The 2nd session – Students searched for answers and concepts using exclusively standard textbooks recommended by the facilitators. The 3rd session – Discussion with group members on the answers, ways to depict relevant concepts/ function, model design and its presentation was done by each group.

The 4th session - Construction of Model: a team leader allocated various tasks to each member of his/her group, Total Duration of these sessions was 3 weeks.

Finally each group displayed and presented their models and charts to the entire class followed by open discussion. Presentation was done on two days consecutively, two groups on the first day and three groups on second day. Evaluation of models was done by senior Faculty from the Department of Physiology based on 4 criteria each carrying ten points.

- Ability of the model to depict the Physiological process
- Ability of the group to explain the function or concept through the model
- Presentation
- Answering to queries

Post-test was taken at the end of the activity for each group separately. A Self-developed validated Feedback questionnaire comprising of ten close ended questions was administered to students for obtaining their perception regarding the activity. The validity of the questionnaire was assessed by senior members of the Medical education unit of the institute. Each item was scored on a 5-point Liker scale to determine the rating of this activity by the students.

MS Excel 2010 software was used for data entry, finding out mean, SD, percentage, and p value. Comparison of pre-test and post-test scores was done by paired t test; p value < 0.05 was considered as statistically significant. Analysis of feedback questionnaire Likert scale response scores and Analysis of Model evaluation score for each criteria was done.

RESULTS

One hundred and ten students participated in the study voluntarily through consent. Models were prepared using simple material like cardboard, paper, and hay. Outcome of the educational intervention was calculated through the post-test scores, assessment of the models by judges, and student feedback regarding the SDL activity of model construction and presentation.

The comparison between pre and post tests taken at the end showed that there was a statistically significant difference in the scores (Table 1).

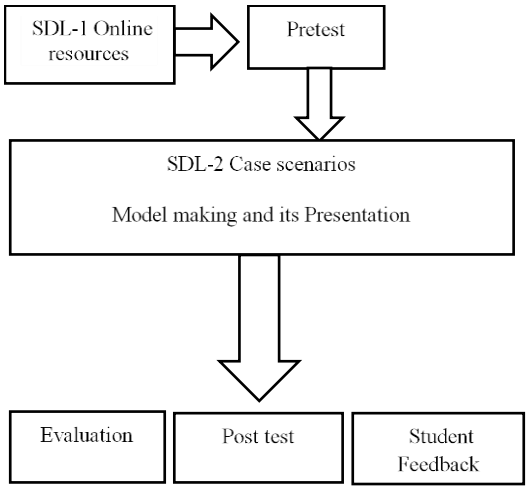

Figure 1. Sequence of the activities conducted

Table 1. Descriptive Statistics of Confidence and Participation Score

Measure	Mean (SD)	N
Confidence	1.96 (0.82)	30
Participation	1.34 (0.32)	30

DISCUSSION

The present researchers have discussed a teaching learning active methodology tool in Medical Physiology based on the use of physical models designed by students. A self-directed learning activity of model making was compared with a SDL activity of searching online resources for an assigned topic. These researchers aimed at students being able to answer the questions pertaining to a case scenario, focussing on comprehension, analysis, and then construction of models for demonstration of a physiological concept. In order to test their hypothesis and find out the learning outcome through the educational intervention, the researchers compared the pre and post test scores. The post-test scores after completion of the model construction and presentation were significantly greater in comparison to the pre-test scores. Although the topics had been taught in the didactic lectures, and online resources had been used; however, the use of models to explain the concept/function/physiology to answer questions with reference to the clinical scenarios proved effective.

Models were evaluated for representativeness that is the capacity to represent a physiological process, and explains the concepts involved. It was seen that groups scored well at designing models and explaining its working, their scores were good for presentation skills; however, the ability to answer queries was fairly well, indicating that more preparation was needed for a comprehensive collection of knowledge and its integration. Consolidating knowledge about the subject matter is a crucial step in "learning how to learn" (6).

Perception of students regarding the effectiveness of this

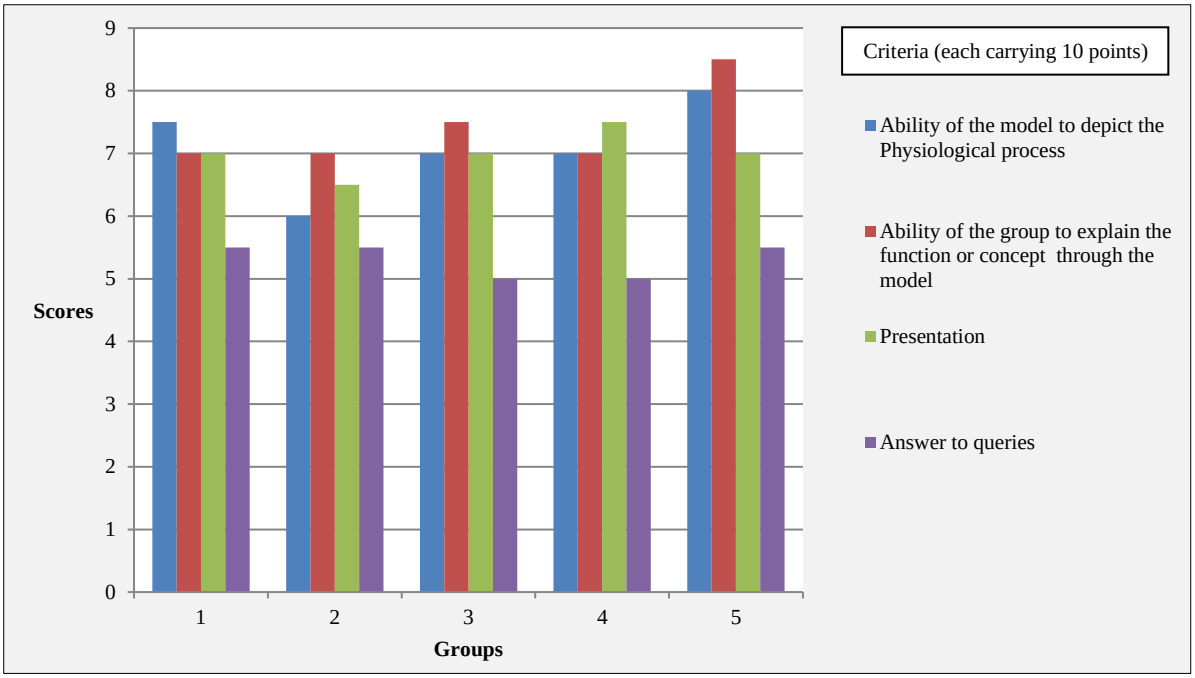

Figure 2. Model evaluation scores of the five groups based on 4 criteria

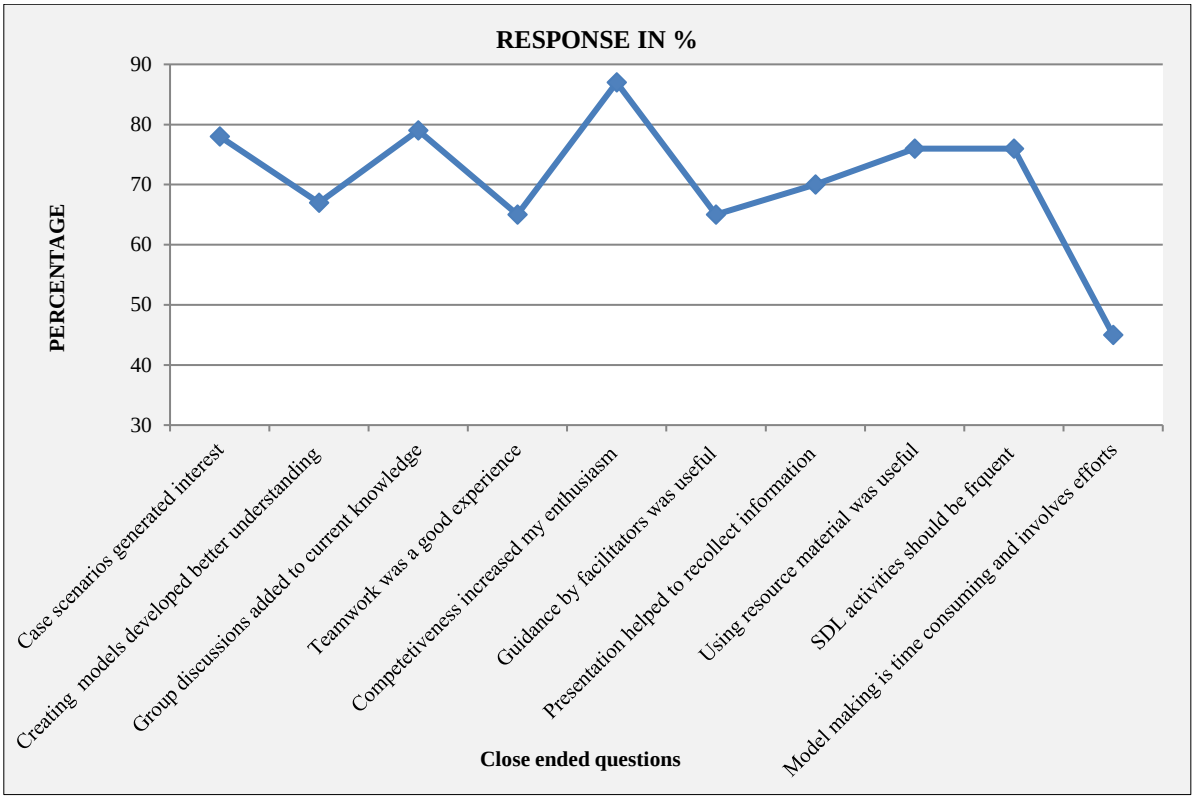

Figure 3. Response of the participants to Feedback questionnaire

activity was positive. Students strongly supported Competitiveness (87%) and group discussions (79%). They perceived the activities as being worthwhile and recommended more of these, although some found this activity time consuming and tiring (45%). Application of a Physiological concept in form of case scenarios acted as a trigger, hence the search for answers initially generated interest and curiosity. Working as a team was a good learning experience for the students. Competitiveness brings out the best in any individual, similarly all the groups tried to construct the best model. Presenting their work rather than mere exhibition of models was found to be helpful by students. Use of standard textbooks helped students understand better, highlighting the fact that there are no alternatives to these books. They recommended such activities frequently.

Previous studies have shown that Manipulatives have been used to improve conceptual understanding, clear misconceptions, improve critical thinking, and suit diverse learning styles (7). The Physiological Physical Models developed by undergraduates and presented at the Symposium on integrated Physiology were considered highly representative of their respective physiological topics (3). Hands-on activities can provide active learning (3,8). Although sophisticated commercial simulators are available for use in practical Physiology classes, they may not be affordable hence students would benefit from handmade models (5,9,10).

According to the Medical council of India's Competency Based Medical Education Curriculum, a student-centric approach to teaching and learning has given major emphasis to Self-directed learning, and 25 hours have been allotted for the same. Students take responsibility for their own learning and the faculty act as facilitators to aid them in this process. Higher number of active engagement strategies in small groups have been used too. Blooms well known taxonomy, places 'Remembering' at the bottom of the hierarchy and 'Creating' at the top.

The present study involved creation and active engagement. Model construction and manipulation encourages dynamic application of concepts to the physical model. The construction gives an opportunity to think, plan, clear misconceptions, and use reasoning skills to replicate the information physically via the model. It is suitable for visual, auditory, kinaesthetic, and tactile learning styles. A learning resource material that students can see, touch, and manipulate during the process of building knowledge is remembered for a long time (11). Knowledge gained by such hands-on learning experience has better chances of retention rather than passively listening to a lecture or passive reading of easily accessible non validated online material. Pant et al in their study also noticed that the activity challenged students' motor and cognitive domains without monotony.

Group activity for students facilitates attributes such as communication, team work, problem solving, information sharing, and respect for peer opinion with better learning outcome and creative thinking skills. The role of the facilitator cannot be undermined, hence it is important for

the facilitator to specify the objectives, assign the groups, explain the task and goal, and assess the effectiveness of the learning groups and the individual student's achievement (12).

The presentation had its advantage as the groups needed to be thorough in their own understanding. At the end of each presentation, there was interaction between students and participants, and queries were answered. Such interaction is a means of identifying and correcting misconceptions. In the absence of peer interaction and student instructor interaction new pedagogies are less effective (13-15). The enthusiastic involvement of the groups as well as non-participants was evident during the sessions and on the day of presentation, pointing to the fact that active learning experiences boost confidence and understanding.

The active engagement learning strategy resulted in knowledge gain as evidenced by students' performance and ability of representativeness. Conventional teaching can be accompanied by such strategies which are novel and realistic, assuring student participation and desirable learning outcomes. These models serve as a good, cheap teaching, and reference resource material for the future batches.

As a suggestion, incomplete and unlabelled models can be created for students to complete and discuss.

Study results were limited for one batch only. Long term effectiveness in form of retention of knowledge gained through this activity was not studied.

Ethical Considerations: Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors. Institutional ethical committee approval was taken prior to the beginning of the study (Approval no. 176/2022 on 11/05/2022).

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Conflict of interest: None

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