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(Research Article)

Comparative research: The use of local strategy and foreign strategy on mental arithmetic calculation

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Abstract

The study entitled "Comparative Research: The Use of Local Strategy and Foreign Strategy on Mental Arithmetic Calculation," intended to examine two methods of mental arithmetic utilized by Calumpang National High School students in Grade 7. The mental abacus was the foreign strategy, and the place value strategy was the local one. Using a pre-test and post-test with randomly selected 30 students for each strategy, the study sought to determine how well students performed in terms of speed and accuracy when performing mental arithmetic. he significant differences between the two techniques were ascertained using the Paired T-test. The study showed that while there were no significant differences between the two strategies in addition and subtraction, there were significant difference in multiplication and division. The findings bared that the effectiveness between the local and foreign strategy on mental arithmetic calculation is considered to be partially significant.

Keywords: Mental Arithmetic Calculation; Local Strategy; Foreign Strategy; Calculation

1. Introduction

In the field of education, mental math serves as a fundamental building block for numerical fluency. However, it is common for students to struggle in developing this essential skill. Mental Arithmetic is the process of computing numbers mentally without the help of any tools like calculator. Students of all ages should be able to perform mental calculation since it is an important skill for them, as it can help them to develop their mathematical understanding and skills.

Some researchers who study mental arithmetic strategies are growing interest in using comparative research where they compare the mental arithmetic strategies that are being used in their area to other strategies that are used by other countries. The use of comparative research will help the researcher to determine what strategy is more effective.

In Laguna University, there is currently no existing research or prior studies about this. This absence of prior research underscores the significance of this investigation and the potential contributions it can make to the academic community.

At Laguna University, there are currently no existing studies or research on this topic. This lack of previous work highlights the importance of this investigation and the potential contributions it can offer to the academic community.

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2. Material and methods

2.1. Research methodology

This section describes the research design, research locale, sample of the respondents, research instruments, data gathering procedure, and data analysis procedure of this study.

2.2. Research Design

In the study titled "Comparative Research: The Use of Local Strategy and Foreign Strategy on Mental Arithmetic Calculation," quantitative research is utilized to systematically gather numerical data by administering a standardized questionnaire to each respondent. The use of the same set of questions for both strategies ensures uniformity in data collection, allowing the researchers to quantitatively assess participants' perceptions, preferences, or performance with each mental arithmetic strategy. This approach provides a structured way to analyze the effectiveness and applicability of each strategy in a measurable format.

The specific quantitative approach used in this context is survey research with a comparative design. This method involves collecting data through questionnaires, which are analyzed statistically to compare the outcomes between the two strategies. Researchers can apply descriptive statistics to summarize the responses and inferential statistics, such as t-tests or ANOVA, to determine whether there are significant differences between the perceptions or performance scores related to the local and foreign strategies. Survey research is a widely recognized quantitative method, supported by proponents like Fowler (2013) who emphasized the importance of questionnaires for gathering consistent and comparable data across different groups. Similarly, Creswell (2014) highlights the value of survey research in quantitative studies, particularly in comparing groups and identifying patterns through statistical analysis.

2.3. Research Locale

This study was conducted at Calumpang National High School, which is located in Calumpang, Nagcarlan, Laguna. The researchers selected Calumpang National High School as the research site because it offers the necessary information and data regarding the students that are required for the study.

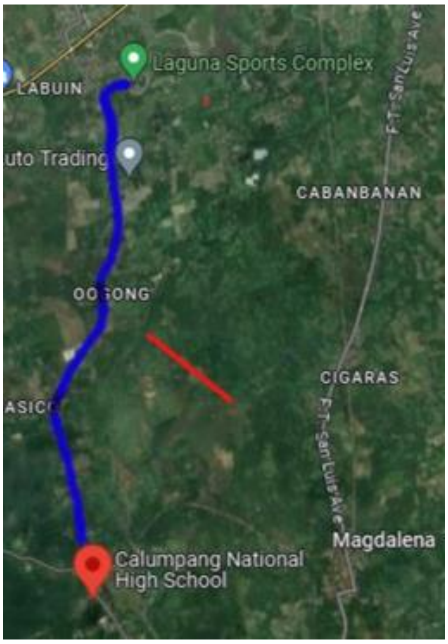

Figure 1 Vicinity Map

2.4. Population of the Study

A population refers to the entire group of individuals that the researcher wants to draw conclusions about. In this study, the population consists of Grade 7 students at Calumpang National High School. The total population of selected Grade 7 students is seventy-one (71).

To determine the sample size for the study, the researchers used Slovin's Formula with a 5% margin of error. Based on the formula, the required sample size is sixty (60) Grade 7 students. The respondents involved in this study are Grade 7 students from Calumpang National High School. It requires sixty (60) Grade 7 students to study.

2.5. Research Instrument

In this study, the researcher developed their own test to collect data on the mental arithmetic calculations of the selected Grade 7 students at Calumpang National High School. It consists of ten (10) item equations for each basic operation, such as addition, subtraction, multiplication, and division, that students' need to answer within the given allotted time. The focus of this test is to measure the mean level of mental arithmetic in terms of speed and accuracy of the selected students at Calumpang National High School.

The researchers employed a 5-point scale, based on Rensis Likert's model, to assess the mean level of mental arithmetic speed among students, using data from pre-tests and post-tests, each conducted within a 10-minute time limit. By dividing the total time (10 minutes) by the four operations, the researchers established specific time intervals to categorize speed levels

This scale interprets the students' completion speed as follows: scores between 0-2.50 reflect the highest level of speed, labeled as "Very Fast"; scores from 2.51-5.00 are categorized as "Fast"; scores from 5.01-7.50 indicate "Slow" speed; and scores from 8.01-10.00 represent the lowest speed, labeled as "Very Slow." This framework enabled researchers to compare pre- and post-test results effectively, providing insight into whether students' mental arithmetic speed improved over time and highlighting areas where additional support might be beneficial.

Table 1 Mean Level of Mental Arithmetic of the Students in terms of Speed

Scale (in terms of minutes)	Interpretation
0 – 2.00	Extremely Fast
2.01 – 4.00	Very Fast
4.01 – 6.00	Neither Fast nor Slow
6.01 – 8.00	Very Slow
8.01 – 10.00	Extremely Slow

Table 2 Mean Level of Mental Arithmetic of the Students in terms of Accuracy

Scale (based on score)	Interpretation
0 – 2.00	Poor
2.01 – 4.00	Fair
4.01 – 6.00	Good
6.01 – 8.00	Very Good
8.01 – 10.00	Excellent

The researchers utilized a 5-point scale, based on Rensis Likert's model, to interpret the mean level of students' mental arithmetic accuracy from pre-test and post-test data, each test containing 10 items per operation. By dividing the number of items (10) by the number of operations (four), they created distinct intervals to evaluate accuracy.

This scale interprets scores as follows: a mean score of 0-2.00 represents the lowest accuracy, labeled as "Poor"; scores from 2.01-4.00 are classified as "Fair"; scores of 4.01-6.00 indicate "Good" accuracy; scores from 6.01-8.00 are labeled as "Very Good"; and scores from 8.01-10.00 indicate the highest accuracy level, termed "Excellent." This framework provided a clear way to assess changes in students' mental arithmetic accuracy, allowing researchers to compare pre-test and post-test results effectively and identify progress or areas still needing improvement in each arithmetic operation.

2.6. Data Gathering Procedure

The data gathering procedure employed by the researchers adhered to a systematic approach to ensure the validity and reliability of the collected data. The initial step was to validate the research instruments. This process involved carefully evaluating the test questionnaires to ensure they were both accurate and appropriate for the intended respondents. Experts in the field were consulted to review the content and structure of the instruments, ensuring they aligned with the objectives of the study and would yield meaningful data.

Subsequently, the researchers prepared an official communication by drafting a formal letter, following a prescribed format. This letter was then presented to the principal of Calumpang National High School, seeking permission to conduct the study and involve the students as respondents. Upon receiving the necessary approval, the researchers proceeded with the data collection phase.

In preparation for data collection, the researchers developed a test questionnaire to be distributed among the respondents. Prior to the distribution of the questionnaires, the researchers met with the respondents and clearly explained the purpose of the study. This step ensured that the participants were fully informed and understood the significance of their participation in the research. Through this structured and transparent procedure, the researchers ensured the ethical and effective collection of data for the study.

2.7. Statistical Treatment of Data

The following statistical procedures were used to interpret the data gathered from the respondents of the study.

Table 3 Statistical tools

Statement of the problem	**Statistical treatment**	**Formula**
What is the mean level of the mental arithmetic of the students in the pre-test results of Place-value strategy and Mental Abacus in terms of: a. Speed b. Accuracy	Mean	$\bar{X} = \frac{\sum X}{n}$
What is the mean level of the mental arithmetic of the students in the post-test results of Place-value strategy and Mental Abacus in terms of: a. Speed b. Accuracy	Mean	$\bar{X} = \frac{\sum X}{n}$
What is the mean level of local strategy and foreign strategy of the mental arithmetic calculation of the students in the post-test results of Place-value strategy and Mental Abacus?	Mean	$\bar{X} = \frac{\sum X}{n}$
Is there a significance difference between the post-test scores of the use of local strategy and foreign strategy on the mental arithmetic calculation?	Paired T-test	$Single\ Factor\ ANOVA$

The table presented statistical analysis tool. It focuses on investigating the effectiveness of different mental arithmetic strategies, namely local and foreign strategies, on students' mental arithmetic performance. The study involves a pre-test and post-test assessment, measuring the mean level of mental arithmetic in terms of both speed and accuracy. The research design utilizes the place-value strategy and mental abacus techniques as teaching methods. The primary research question investigates whether there's a significant difference in post-test scores between students using local and foreign strategies. To analyze the data, the study employs statistical tests, namely the paired t-test and single-factor ANOVA, to determine the statistical significance of the observed differences. This table provides a clear overview of the research design and statistical analysis plan, highlighting the key research questions and the statistical methods used to address them.

3. Results and discussion

3.1. Presentation, analysis, and interpretation of data

This chapter presents the results, analysis, and interpretation of data gathered from the answers to the questionnaires distributed. These are presented in tabular form in accordance with the specific questions posited in the statement of the problem.

The aim of this study was to find out if there is a significant difference between the use of local strategy and foreign strategy in mental arithmetic calculation. The data collected from the students was analyzed and interpreted to gain insights into the use of strategies in mental arithmetic calculation.

In today's era, with everyone using digital devices such as calculator and online mathematical tools, the importance of mental calculation is still being addressed and studied. Mental calculation is vital for developing critical thinking skills and mental coordination. As our world changes, the ability for rapid mental calculations is still important in scenarios where access to or viability of electronic devices may be limited. Additionally, mentally performing calculations is a type of brain training that improves cognitive function. Furthermore, highlighting mental calculations as a basic ability and acknowledging its significance for building a solid mathematical foundation and fostering success in a range of academic fields including science, technology, engineering, and mathematics.

3.1.1. Speed

Table 4 The Mean Level of Mental Arithmetic of the students on the Pre-Test Results of Place-Value Strategy and Mental Abacus in terms of:

Table 4a Place Value Strategy

Place Value Strategy				
Time interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 minutes	0	0	0	0
2.01 – 4.00 minutes	5	2	0	0
4.01 – 6.00 minutes	4	4	4	0
6.01 – 8.00 minutes	9	5	2	2
8.01 – 10.00 minutes	12	19	24	28
Mean	7.13	7.98	9.03	9.53
Grand mean	8.42 – Extremely Slow			

Table 4b Mental Abacus Strategy

Mental Abacus Strategy				
Time interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 minutes	2	3	0	1
2.01 – 4.00 minutes	4	11	2	0
4.01 – 6.00 minutes	7	4	3	5
6.01 – 8.00 minutes	10	5	6	7
8.01 – 10.00 minutes	7	7	19	17
Mean	6.27	5.32	8.14	8.02
Grand mean	6.94 – Very Slow			

The presented tables offered a comprehensive analysis of student performance in place value strategy across the four fundamental arithmetic operations: addition, subtraction, multiplication, and division. The data reveals that students' speed in place value strategy, as evidenced by a grand mean score of 8.42, which is classified as "Extremely Slow," their performance varies insignificantly across different operations. Addition emerges as the area of greatest strength, with the highest mean score, while division demonstrates the lowest mean score, suggesting a need for additional support and practice in this specific operation. And for mental abacus, the grand mean score is 6.94 and is interpreted as" Very Slow". Furthermore, an examination of the distribution of scores across different score intervals provide valuable insights into student performance.

3.1.2. Accuracy

Table 4c Place Value Strategy

Place Value Strategy				
Score interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 points	1	9	16	6
2.01 – 4.00 points	1	8	8	7
4.01 – 6.00 points	7	8	4	11
6.01 – 8.00 points	10	3	2	6
8.01 – 10.00 points	11	2	0	0
Mean	7.70	4.23	2.73	4.60
Grand mean	4.82 – Good			

Table 4d Mental Abacus Strategy

Mental Abacus Strategy				
Score interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 points	1	5	9	7
2.01 – 4.00 points	4	13	9	4
4.01 – 6.00 points	5	6	4	12
6.01 – 8.00 points	8	5	4	6
8.01 – 10.00 points	12	1	4	1
Mean	7.43	4.53	4.23	4.83
Grand mean	5.26 – Good			

The tables above representing place value strategy reveals a significant disparity in student performance across the four arithmetic operations. Addition demonstrates the highest mean score at 7.70, suggesting strong proficiency in this area. Multiplication, however, presents a significant challenge, with the lowest mean score of 2.73. This suggests a need for focused instruction and practice to improve students' grasp of multiplication concepts.

In the mental abacus analysis, a similar disparity is evident. Addition again demonstrates the highest mean score of 7.43, suggesting that students find this operation relatively easy. Conversely, multiplication shows the lowest mean score of 4.23, indicating a significant challenge for students. This suggests that students may require additional support and practice in multiplication to improve their understanding and proficiency.

Table 5 The Mean Level of Mental Arithmetic of the Students on the Post-Test Results of Place-Value Strategy and Mental Abacus in terms of:

3.1.3. Speed

Table 5a Place Value Strategy

Place Value Strategy				
Score Interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 minutes	0	0	0	0
2.01 – 4.00 minutes	1	0	0	0
4.01 – 6.00 minutes	12	6	2	2
6.01 – 8.00 minutes	10	7	5	5
8.01 – 10.00 minutes	7	17	23	23
Mean	7.47	8.72	9.29	9.11
Grand Mean	8.65- Extremely Slow			

Table 5b Mental Abacus Strategy

Mental Abacus Strategy				
Score Interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 minutes	0	0	0	0
2.01 – 4.00 minutes	0	0	0	1
4.01 – 6.00 minutes	0	1	0	0
6.01 – 8.00 minutes	7	5	4	2
8.01 – 10.00 minutes	23	24	26	27
Mean	8.91	8.88	9.43	9.07
Grand Mean	9.07- Extremely Slow			

The data illustrates the comparison of the speed of two different mental arithmetic calculation strategies. The data is organized by time intervals, with each interval representing a range of time taken to complete a calculation. The number of students completing the calculation within each interval is recorded for each operation (addition, subtraction, multiplication, and division) under each strategy. Both strategies show a generally slow speed across all operations, with the majority of students taking more than 0.81 minutes to complete a calculation. However, the Mental Abacus Strategy shows a slightly faster speed overall, indicated by a Grand Mean of 9.07 minutes, categorized as "Extremely Slow," compared to the Place Value Strategy's Grand Mean of 8.65 minutes, also categorized as "Extremely Slow." This suggests that the Mental Abacus Strategy might be slightly faster, but both strategies are generally slow in terms of completing mental arithmetic calculations. Further research could explore the factors contributing to the slower speed of both strategies, such as the complexity of the calculations or the students' familiarity with the strategies.

3.1.4. Accuracy

Table 5c Place Value Strategy

Place Value Strategy				
Score Interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 Points	0	4	14	1
2.01 – 4.00 points	0	8	7	4
4.01 – 6.00 Points	3	9	4	6
6.01 – 8.00 points	13	5	2	13
8.01 – 10.00 points	14	4	3	6
Mean	8.27	5.37	3.56	6.73
Grand Mean	5.98- Good			

Table 5d Mental Abacus Strategy

Mental Abacus Strategy				
Score Interval	Addition	Subtraction	Multiplication	Division
0.00 – 2.00 Points	1	1	4	2
2.01 – 4.00 points	0	3	6	4
4.01 – 6.00 Points	6	16	9	9
6.01 – 8.00 points	2	7	7	7
8.01 – 10.00 points	22	3	4	8
Mean	8.07	5.43	5.56	6.67
Grand Mean	6.43- Very Good			

The data illustrates the comparison of the speed of two different mental arithmetic calculation strategies. The data is organized by time intervals, with each interval representing a range of time taken to complete a calculation. The number of students completing the calculation within each interval is recorded for each operation (addition, subtraction, multiplication, and division) under each strategy. Both strategies show a generally slow speed across all operations, with the majority of students taking more than 0.81 minutes to complete a calculation. However, the Mental Abacus Strategy shows a slightly faster speed overall, indicated by a Grand Mean of 9.07 minutes, categorized as "Extremely Slow," compared to the Place Value Strategy's Grand Mean of 8.65 minutes, also categorized as "Extremely Slow." This suggests that the Mental Abacus Strategy might be slightly faster, but both strategies are generally slow in terms of completing mental arithmetic calculations. Further research could explore the factors contributing to the slower speed of both strategies, such as the complexity of the calculations or the students' familiarity with the strategies.

Table 6 The mean level of local strategy and foreign strategy of the mental arithmetic calculation of the students in the post-test results of Place-value strategy and Mental Abacus:

Place Value Strategy						
	Scores					
Student No.	Addition	Subtraction	Multiplication	Division	Total Score	Mean
1	7	2	2	4	15	3.75
2	10	5	7	4	26	6.5
3	10	5	6	4	25	6.25
4	4	0	1	2	7	1.75
5	10	2	0	5	17	4.25
6	10	2	1	6	19	4.75
7	8	4	0	5	17	4.75
8	9	4	1	1	15	3.75
9	10	6	4	6	26	6.5
10	10	6	4	5	25	6.25
11	10	6	4	4	24	6.0
12	5	0	1	4	10	2.5
13	10	9	6	8	33	8.25
14	8	5	3	4	20	5.0
15	6	4	0	1	11	2.75
16	6	4	2	6	18	4.5
17	8	8	2	5	23	5.75
18	8	4	4	5	21	5.25
19	5	3	1	5	14	3.5
20	2	2	1	4	9	2.25
21	6	3	6	8	23	5.75
22	5	3	5	7	20	5.0
23	8	9	3	5	25	6.25
24	9	6	4	5	24	6.0
25	7	8	8	8	31	7.75
26	8	6	3	7	24	6.0
27	10	8	2	8	28	7.0
28	8	1	0	2	11	2.75
29	6	2	1	0	9	2.25
30	8	0	0	0	8	2.0
Grand Mean		4.83 - Good				

The table presents an analysis of student performance in place value strategy across addition, subtraction, multiplication, and division. While the overall proficiency is rated as "Good," with a grand mean score of 4.83, performance varies by operation. Addition stands out with the highest mean score, followed by division, while subtraction and multiplication show lower scores, indicating a need for focused instructional support.

Further analysis of score distribution reveals that most students excelled in addition, with many scoring in the 6.01-8.00 range. In contrast, multiplication had the fewest students scoring in the 0.00-2.00 range, highlighting it as a key area for targeted intervention.

Table 7 Mental Abacus Strategy

Mental Abacus Strategy						
	Scores					
Student No.	Addition	Subtraction	Multiplication	Division	Total Score	Mean
1	10	6	2	3	21	5.25
2	9	5	2	4	20	5.0
3	10	8	2	2	22	5.5
4	9	3	3	2	17	4.25
5	9	5	4	5	23	5.75
6	9	7	9	6	31	7.75
7	0	3	7	3	13	3.25
8	9	4	7	6	26	6.5
9	10	5	6	5	26	6.5
10	4	3	4	3	14	3.5
11	10	7	6	5	28	7.0
12	10	7	6	5	28	7.0
13	9	1	6	7	23	5.75
14	5	4	3	10	22	5.5
15	10	4	6	10	30	7.5
16	10	4	8	10	32	8.0
17	9	4	4	8	25	6.25
18	10	7	9	10	36	9.0
19	9	9	3	8	29	7.25
20	9	6	7	10	32	8.0
21	10	7	9	10	36	9.0
22	10	9	9	10	38	9.5
23	4	4	0	5	13	3.25
24	10	9	7	10	36	9.0
25	9	4	8	8	29	7.25
26	8	7	6	6	27	6.75
27	4	5	6	8	23	5.75
28	7	6	7	7	27	6.75

29	4	4	6	8	22	5.50
30	6	6	5	6	23	5.75
Grand Mean		6.43 – Very Good				

The table presents a detailed analysis of student performance in mental abacus across addition, subtraction, multiplication, and division. While students generally perform well, with a grand mean score of 6.43 ("Very Good"), there are notable variations between operations. Addition is the strongest area, followed by division, while subtraction and multiplication show lower scores, indicating the need for targeted instructional support. The score distribution also reveals key insights: most students scored in the 8.01-10.00 range for addition, while multiplication had the fewest students in the 0.00-2.00 range, highlighting the need for focused intervention.

Table 8 Test of Difference between the Use of Local and Foreign Strategies on the Mental Arithmetic Calculation

Criteria	**Variables**	**SS**	**Df**	**MS**	**F-stat**	**p-value**	**Analysis**
Addition	Test	10.800	1	10.8	2.193	0.141	Not Significant
	Strategies	1.633	1	1.633	0.332	0.566	Not Significant
	Test*Strategies	0.033	1	0.033	0.008	0.935	Not Significant
Subtraction	Test	31.008	1	31.008	5.490	0.021	*Significant*
	Strategies	1.008	1	1.008	0.179	0.673	Not Significant
	Test*Strategies	0.408	1	0.408	0.072	0.788	Not Significant
Multiplication	Test	35.208	1	35.208	5.131	0.025	*Significant*
	Strategies	91.875	1	91.875	13.389	0.000	*Significant*
	Test*Strategies	1.875	1	1.875	0.273	0.602	Not Significant
Division	Test	3979.008	1	3979.008	263.285	0.000	*Significant*
	Strategies	2774.408	1	2774.408	183.578	0.000	*Significant*
	Test*Strategies	2641.408	1	2641.408	174.778	0.000	*Significant*

From this table, the result of the ANOVA analysis for two mental arithmetic strategies, local and foreign, is shown. For each kind of operation—added, subtracted, multiplied, and divided—the sum of squares (SS), degrees of freedom (DF), mean squares (MS), F-statistic (F-stat), p-value, and analysis result were provided. From the analysis, it is evident that the local and foreign strategies differ at a significant level solely for division alone with a p-value of less than 0.05, and therefore this is statistically significant in terms of the effectiveness difference between the two strategies for division and not for addition, subtraction, and multiplication operations, which had p-values greater than 0.05. Consequently, the data gives an indication that foreign strategy is significantly better in the division compared to local strategy; however, it does not show a statistical difference concerning other operations.

3.2. Conclusion

The ANOVA results indicate that the hypothesis of a significant difference between local and foreign mental arithmetic strategies is rejected for addition, subtraction, and multiplication, as all these operations have p-values greater than 0.05, showing no statistical significance. However, the hypothesis is accepted for division, as both local and foreign strategies demonstrate statistically significant differences from each other, with p-values less than 0.05, underscoring a significant effectiveness difference between the two strategies in this operation. Considering the ANOVA results across all operations, the overall hypothesis that there is a significant difference between local and foreign mental arithmetic strategies is rejected. This decision is based on the fact that a statistically significant difference was only observed in the division operation, while no significant differences were found in addition, subtraction, and multiplication. Thus, the majority of operations show no substantial differences between the strategies.

Compliance with ethical standards

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Disclosure of conflict of interest

If two or more authors have contributed in the manuscript, the conflict-of-interest statement must be inserted here.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study."

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