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ORIGINAL ARTICLE

Comparison of Reaction Times for Three Forms of Punches among Amateur Boxing Athletes of the Thailand National Team

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ABSTRACT

Background. There are limited studies of the reaction time of throwing punches in Thai Amateur Boxing athletes. Amateur Boxing which is point-scoring blows, based on the number of clean punches landed to movable specific areas. This study will be baseline information for developing Amateur Boxing athletes. **Objectives.** To compare the reaction time of punches; left, right, double punches. **Methods.** Twelve participants were male Amateur Boxing athletes of the Thailand National Team, 18–35 years old, Welterweight – Light Heavyweight, right-handedness. Participants warmed up and familiarized themselves with the procedure, then randomly selected order and performed 3 sets of left, right, and double punch over 60 seconds, using SMART fit to measure the number of punches thrown per stimulus (times/second), the fastest punching time per stimulus (seconds), the average reaction time to stimulus (seconds) of each punch type. **Results.** Using One-Way Repeated Measures ANOVA, the number of punches thrown per stimulus between left and double punch was a significant difference ($p<0.001$); also between right and double punch ($p<0.001$). The fastest punching time per stimulus was a significant difference between left and double punch ($p=0.006$). The average reaction time to the stimulus was a significant difference between left and double punch ($p<0.001$), and also between right and double punch ($p<0.001$). **Conclusion.** Throwing double punch produced the highest number of punches thrown, the fastest punching time, and a better average reaction time per stimulus than left or right punch. In terms of the reaction time to stimulus, throwing double punch is the most effective but the left punch is less effective form of punch.

KEYWORDS: ***Reaction Times, Left Punch, Right Punch, Double Punch, Amateur Boxing, Athletes.***

INTRODUCTION

Amateur Boxing is one kind of sport that is a variant of boxing practiced at the collegiate level, at the Olympic Games, Pan American Games, and Commonwealth Games. Amateur Boxing is a widely popular fighting sport (1, 2). This type of competition prizes point-scoring blows, based on number of clean punches landed to the movable specific areas, rather than physical power. Studies of physical fitness of Amateur Boxing athletes, such as their number of clean punches thrown per stimulus, their fastest punching time per stimulus, and their average reaction time to a stimulus with different forms of punches allow Amateur Boxing athletes to further improve their skills, gain a competitive edge, and have a higher winning chance in the competition (3-5). Practicing with the aim of improving the punching speed and the reaction time of hand and body movement will allow Amateur Boxing athletes to cultivate the important skills necessary for them to become

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professionals (5). Many research studies that were widely cited and referenced also indicate that good practice plans that focus on improving Amateur Boxing athletes' different forms of punches will allow them to be more successful in their careers (6-10). Many other research studies also indicate that regularly practicing Amateur Boxing would improve one's strength and reaction time with punching (11). The majority of research studies nowadays focus on comparing different forms of punches, including among male and female boxers (3, 12); as well as on the angular movement of various body parts and the sequential force generation of various joints for punching (13-15). In order to conduct such studies, many researchers invented and created various machines used for measuring the force of the punch, the number of punches per stimulus, the fastest punching time per stimulus, and the average reaction time of punching, etc (16-18). Therefore, the primary objectives of this study are to study and compare the 3 forms of punches, namely, the left punch, the right punch, and the double punch among Amateur Boxing athletes of the Thailand National Team. The researchers collected the data during a period of 60 seconds of the experiment, namely, the number of punches thrown per stimulus (times/second), the fastest punching time per stimulus (seconds), and the average reaction time to stimulus (seconds). The researchers aim to establish the baseline of different forms of punches and use the data to design training programs that specifically aim to improve the efficiency of professional Amateur Boxing athletes' punches, in order to improve their chance of success in their career and winning at the Olympic-level competition.

MATERIALS AND METHODS

Design. This study was approved by the Human Research Ethics Committee of Thammasat University (Science) (Certificate of Approval No. 004/2563). All participants read and signed the consent form before participating in the study.

Participants. The researchers do not calculate the sample size because the participants are the limited specific group which is the Amateur Boxing athletes of the Thailand National Team who will compete in the 2024 Olympic Games. Therefore, the participants were selected using the purposive sampling method. The researchers advertised the invitation letter and requested support to conduct the research study with the Amateur Boxing Association of Thailand. In terms of inclusion criteria, participants must be Thai Amateur Boxing athletes of the Thailand National Team who will compete in the 2024 Olympic Games, male, at the ages between 18-35 years old, right-handedness, in the weight class between the Welterweight - Light Heavyweight (63.503-79.379 kg), participants must have no history of serious musculoskeletal injury for at least 6 months. They must be in good health, with no congenital disease, with a body mass index that is in the range of 18.50–24.90 kg/m^2. In terms of exclusion criteria, participants are unable to do so along with the orders of the researchers. Before the experiment, participants were required to complete the Pre-exercise Risk Factor Assessment form (PAR-Q+2019) (19) in the Thai version.

Procedure. This research study was an Experimental Research Design, in the form of a single-group, repeated-measures design. The researchers studied and compared the reaction times of different forms of punches, namely, the left punch, the right punch, and the double punch. The researchers spent 1 day prior to the experimentation date preparing the avenue by installing the 4 SMART fit, Inc. machines (Ventura, California) (20) (dimension: 25.40*25.40*5.08 cm per one SMART fit machine and 50 centimeters apart from each one from the center). This is a standardized physical fitness measuring machine that is commonly used in boxing-related research. It is capable of measuring the number of punches thrown per stimulus, the fastest punching time per stimulus, and the average reaction time to a stimulus with a high level of precision. This machine is also commonly used as part of most boxing training programs (20). For this experiment, the researchers placed the machines on a stand, at a height of 160 centimeters above the ground. Because the researchers would like to control the factors that might affect on throwing punches of the participants. The reason is the average human height ranges from maximum to minimum between 178.60-161.60 centimeters (21). Therefore, the researchers set the height of the SMART fit machines at 160 centimeters, the same for every participant, which is the level of a human face or the tip of the chin which is an important area where the athletes practice throwing punches and attacking their opponents for getting the scores; and set the area of movement to be 150 centimeters wide and 200 centimeters long. On the day of the experiment, the researchers explained

the details of the research procedures to participants who had been screened and selected. After participants thoroughly understood and agreed to the research procedures, the researchers asked them to sign the informed consent form for participation. The participants were then put through a general physical examination and asked to perform 10-minute warm-up exercises. The warm-up exercises included 5 minutes of cycling and 5 minutes of stretching and punch form practicing. There were fitness experts to lead the participants during the warming up and stretching. After they completed the warm-up exercises, the researchers asked participants to familiarize themselves with the experiment by standing on the test ground while posting the Orthodox Stance, that is, placing the left foot in front of the body and the right foot behind the body and guarding the body with left arm in the front and right arm in the back. Before initiating the test, participants were placed in a position where their left hands were 15 centimeters away from the SMART fit machines. This was done by using the measuring tape to measure the distance between the border of the area of movement and the sensor of the SMART fit machines. To familiarize themselves with the test procedures, participants were asked to remain within the area of movement and then throw the three forms of punches for 30 seconds. After that, the researchers initiated the real test, where the order of the forms of punches was randomly selected and participants were asked to continually throw each form of punch for 60 seconds. Participants were instructed to throw their punches as fast as possible to the stimulus, that is, the LED lights target at the machines. The test was conducted for 3 sets with the 3 forms of punches, namely, the left punch, the right punch, and the double punch. The machines meanwhile measured 3 values, namely, the number of punches thrown per stimulus (times/second), the fastest punching time per stimulus (seconds), and the average reaction time to stimulus (seconds). After collecting the data, the researchers calculated the average values from the 3 sets. There were 3-minute breaks between sets and 10-minute breaks between forms. After the test was completed, the fitness experts then led the participants to perform stretching and cool-down exercises, in order to reduce the chance of injury among participants. The data collection procedure is depicted in Figure 1.

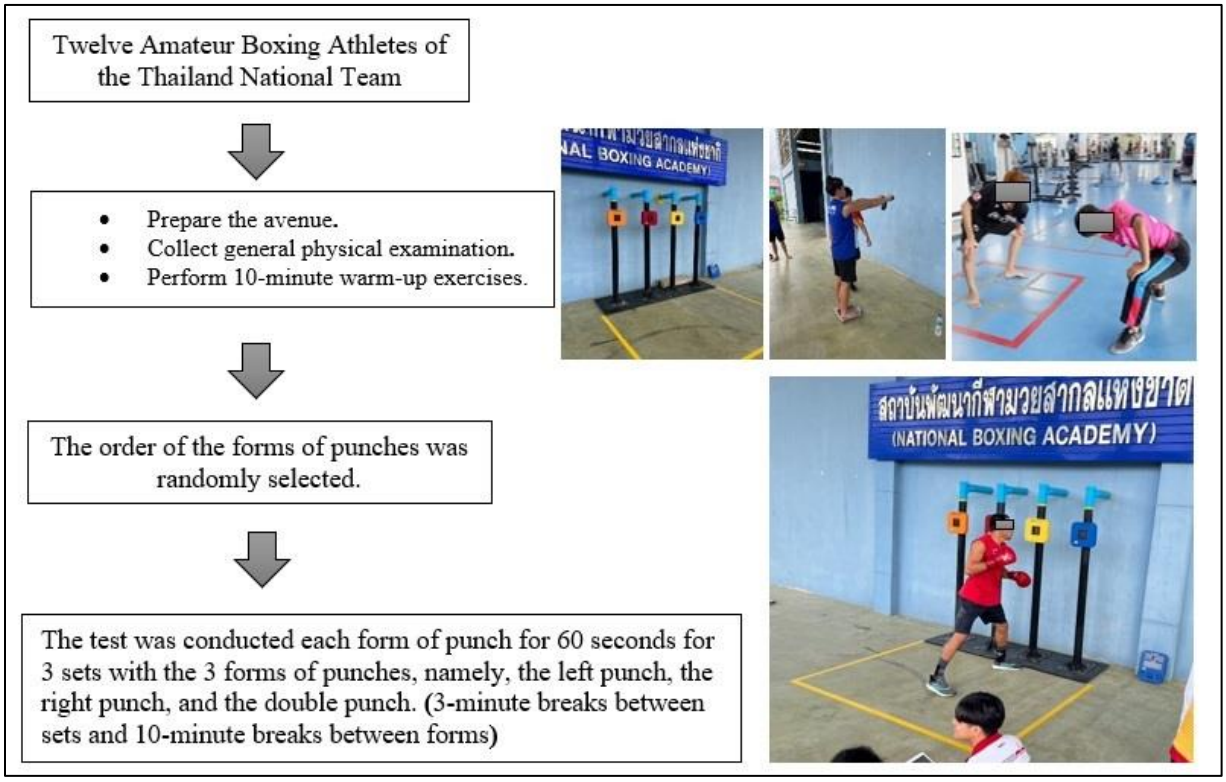

Figure 1. Data Collection Procedure.

Statistical Analysis. The researchers collected general information and data on the number of punches thrown per stimulus (times/second), the fastest punching time per stimulus (seconds), and the average reaction time to stimulus (seconds) from different forms of punches; and then performed the statistical analysis on said data using the SPSS Application. (Version 26, Chicago, IL, USA) For the testing of normal distribution, the researchers used the Shapiro-Wilk test. If the data has a normal distribution, then the One-Way Repeated Measures ANOVA would be used. Otherwise, the Friedman Test would be used, in order to compare the number of punches thrown per stimulus, the fastest punching time per stimulus, and the average reaction time to stimulus of different forms. Post hoc Bonferroni was used in multiple comparisons. The significance level was set at p=0.05.

RESULTS

There were 18 participants who applied to participate in this research. Among them, 6 participants did not meet the inclusion criteria (3 participants were suffering from previous injuries, and the other 3 were infected with COVID-19) and thus there were a total of 12 participants selected for this research. The baseline characteristics of the participants are shown in Table 1.

Table 1. The baseline characteristics of the participants (n=12)

Baseline characteristics of participants	Mean±SD
Age (years)	23.25±4.09
Height (cm)	172.16±6.78
Weight (kg)	65.49±9.79
BMI (kg/m²)	21.99±2.11
Left Arm Length (cm)	72.12±5.06
Right Arm Length (cm)	72.16±5.28
Left Arm Circumference (cm)	24.06±5.24
Right Arm Circumference (cm)	25.49±5.30
Full Inhalation Chest Circumference (cm)	87.38±5.40
Full Exhalation Chest Circumference (cm)	84.20±5.20

Table 2 depicts the average values and standard deviations of the number of punches thrown per stimulus (times/second), the fastest punching time per stimulus (seconds), and the average reaction time to a stimulus (seconds) for each form of punch, during a period of 60 seconds.

According to the Normality Test, it has been found that the collected data has a normal distribution, with equal variances among all groups. Further comparison of each pair of the tests, using the Bonferroni Method, provides further explanations, as follows: The test of the within-subject effect found a significant difference in the number of punches thrown per stimulus (Sum of square=0.350, df=1.697, Mean square=0.206, F=30.396 p<0.001; Huynh-Feldt). Pairwise comparison found that between throwing the left punch and the double punch were different with statistical significance (Mean Difference=-0.240, Std. Error=0.035, p<0.001) and pairwise comparison found the right punch and the double punch were different with statistical significance (Mean Difference=-0.143, Std. Error=0.020, p<0.001). But pairwise comparison found that between throwing the left punch and the right punch were not different with statistical significance (Mean Difference=-0.097, Std. Error=0.035, p=0.059).

Test of the within-subject effect found a significant difference in the fastest punching time per stimulus (Sum of square=0.054, df=1.432, Mean square=0.037, F=7.877, p=0.008; Greenhouse-Geisser). In terms of the fastest punching time per stimulus, the result revealed differences of statistical significance between throwing the left punch and the double punch (Mean Difference=0.093, Std. Error=0.023, p=0.006) but pairwise comparison found that between throwing the left punch and the right punch were not different with statistical significance (Mean Difference=-0.060, Std. Error=0.030, p=0.211) and pairwise comparison found that between throwing the right punch and the double punch were not different with statistical significance (Mean Difference=0.033, Std. Error=0.017, p=0.214).

Test of the within-subject effect found a significant difference in the average reaction time

to stimulus (Sum of square=0.071, df=1.362, Mean square=0.052, F=29.062, p<0.001; Greenhouse-Geisser). There were differences of statistical significance between throwing the left punch and the double punch (Mean Difference=0.107, Std. Error=0.016, p<0.001), as well as between throwing the right punch and the double punch (Mean Difference=0.067, Std. Error=0.008, p<0.001) but not for the case of between throwing the left punch and the right punch (Mean Difference=0.040, Std. Error=0.017, p=0.120), as depicted in Figure 2.

Table 2. Shows the average values and standard deviations of the number of punches thrown per stimulus, the fastest punching time per stimulus, and the average reaction time to a stimulus for each form of punch

Forms of Punches	The number of punches thrown per stimulus (times/second)	The fastest punching time per stimulus (seconds)	The reaction time to stimulus (seconds)
Left punch	1.24±0.88	0.28±0.08	0.51±0.07
Right punch	1.34±0.74	0.22±0.07	0.47±0.04
Double punch	1.48±0.09	0.19±0.08	0.41±0.05

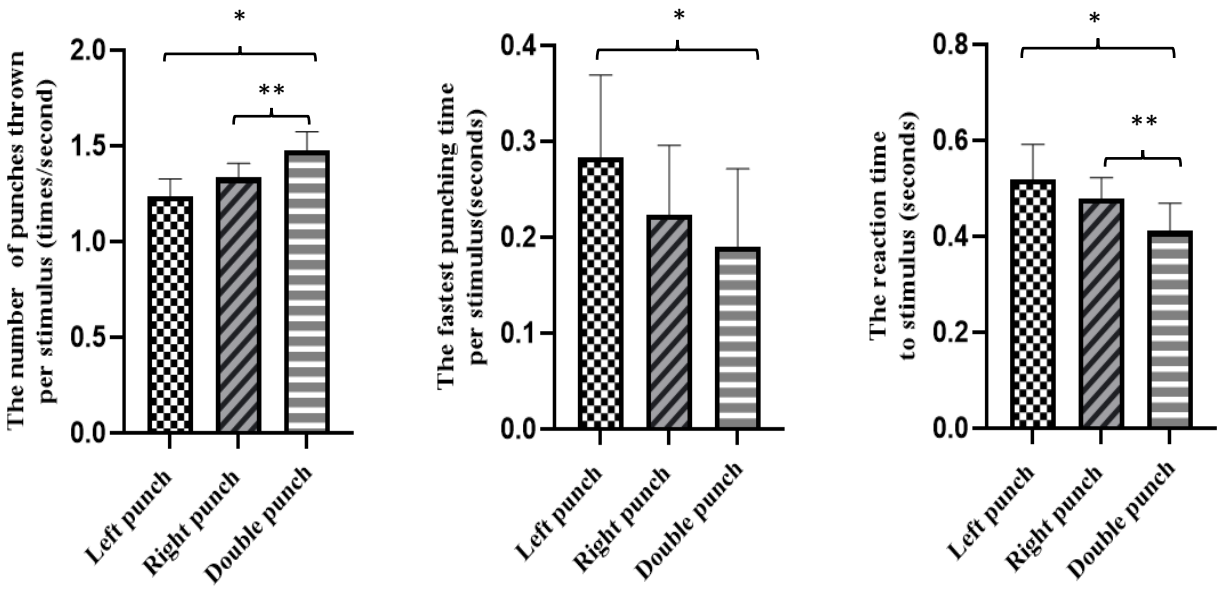

Figure 2. Comparison of the number of punches thrown per stimulus, the fastest punching time per stimulus, and the average reaction time to stimulus from throwing the left punch, the right punch, and the double punch. *: Significant difference from the left punch within the double punch. **: Significant difference from the right punch within the double punch.

DISCUSSION

This study reveals that, in terms of the number of punches per stimulus, the number of left punches thrown was less than the number of right punches thrown. If the Amateur Boxing athletes are right-handed, they usually use the Orthodox Stance when guarding. With this stance, the left fists will be in front and used for throwing jabs or defending while the right fists will be in the back and used as the primary weapon for offense. And since Amateur Boxing athletes are right-handed with right hands are dominant hands, they tend to response a better reaction time per stimulus with their right fists, in comparison to throwing jabs with their left fists. Therefore, the result shows that using the dominant hands allows Amateur Boxing athletes to respond with a better reaction time per stimulus than using the non-dominant hands. Moreover, the Orthodox Stance allows right-handed Amateur Boxing athletes to have a longer range of movement with their right hands that is then transformed into responding faster per stimulus. In addition, in terms of the number of punches thrown per stimulus, it has been found

that throwing the left punch or the right punch tends to produce a smaller number of punches, in comparison to throwing the double punch. This is because the reaction time when throwing the double punch tends to be shorter. As a result, the total number of punches when throwing double punch is higher than throwing either left or right punch similar to the research of M. Veit et al., 2008 (22).

In terms of the fastest punching time per stimulus, throwing the left punch appears to be slower than throwing the right punch, even though there was no difference of statistical significance between throwing the left punch and the right punch. According to the researchers' observation during the experiment, though the left fists was closer to the target than the right fists, with Orthodox Stance the Amateur Boxing athletes had a longer range of movement that allowed them to significantly increase the speed and force of their right punch. This was because the right punch came from fully utilizing the elbow extension and the full range of motion of the elbow. As a result, Amateur Boxing athletes were able to throw faster and more powerful right punches, in comparison to throwing jabs with the left fists, in which they had a shorter range of motion and were not able to fully extend their elbow. This finding is in line with a research study by Barry A. Piorkowski et al., 2011 (23), who found that boxers could not throw jabs with their left fists as fast as when they threw right punches, whereas the difference showed statistical significance. Additionally, our research study reveals that, in terms of the fastest punching time per stimulus, the fastest punching times when throwing the left punch and right punch were shorter, in comparison to throwing the double punch. This was because Amateur Boxing athletes tend to throw faster punches when throwing double punches and, as a result, they were able to throw faster punches with double punches than with either left or right punches, especially in a situation that involves repeated and continual movement of both hands which is similar results to the research of M. Veit et al., 2008 (22).

On the other hand, the average reaction time to stimulus time of throwing the left punch was longer, in comparison to throwing the right punch, even though there was no difference of statistical significance between throwing the left punch and the right punch. The primary reason for this result is because Amateur Boxing athletes are right-handedness, they were able to react faster when throwing right punches, with their dominant hands, in comparison to throwing left punches with their non-dominant hands. This finding is in line with a research study by Dana Badau et al., 2018 who studied Amateur Boxing athletes and found that boxers showed significantly faster reaction time with their dominant hands, in comparison to their non-dominant hands (24). Therefore, it is recommended that coaches should train Amateur Boxing athletes to improve the reaction time of their non-dominant hands since there are several research studies that found that athletes who were left-handed or trained to use more of their left hands had a higher chance of winning, especially among athletes in the combat sports. This finding can be explained by the principle of the negative frequency-dependent selection mechanism (25, 26). In addition, this research study found that the average reaction times to the stimulus of throwing the left punch and the right punch were higher than those of throwing the double punch. Participants tend to react faster to stimulus and have good coordination when using both hands to throw double punches, in comparison to throwing either left or right punches. The reason is the participants are Amateur Boxing athletes which is a sport that uses both hands naturally so the athletes always practice and are familiar with the double punch. Several research studies found that using both limbs while practicing has a positive effect on the development of distal fine motor control (27), as well as the sensory and motor mechanisms in the brain, which are vital components for further improving the coordination of both hands while punching that coaches should not overlook. In this regard, coaches should find means to improve the sensory and motor mechanisms in the brains of Amateur Boxing athletes, in combination with appropriate nutrition plans that promote brain functions, in order to improve boxers' ability to better control the movement of their muscles and joints used for punching (28-30). Moreover, the research of S. El Ashker, 2018 shows us that there is room for improvement for Amateur Boxing athletes if they attend the appropriate training programs regularly. In that research study, the researchers focused on many general activities aimed at improving general fitness performance, such as 30-meter sprints and 5*10 shuttle sprints; as well

as specialized activities aimed at strengthening their muscles, such as push-ups, long jump, or sit-ups. These two types of activities also contribute to the improvement of athletes' techniques, movement, and punching skills (31).

CONCLUSION

In this research study, the researchers studied participants who were Amateur Boxing athletes of the Thailand National Team which will compete in the 2024 Olympic Games in Paris. The result showed that the number of punches thrown per stimulus was higher with throwing the double punch, in comparison to throwing either the left punch or right punch. On the other hand, the average fastest punching time per stimulus of throwing the double punch was faster than throwing the left punch, and the average reaction time to the stimulus of throwing the double punch was faster than throwing either the left or right punch. According to these results, it can be concluded that throwing the double punch produced the highest number of punches thrown per stimulus, in comparison to other forms of punches, as well as yielded the fastest punching time per stimulus, and a better average reaction time per stimulus than throwing either left or right punch. The result thus shows us that throwing the double punch is the most effective form of punch, in terms of the reaction time to stimulus. On the contrary, throwing the left punch is a less effective form of punches, in terms of the reaction time to stimulus. Therefore, coaches should train Amateur Boxing athletes to improve their reaction time to stimulus, with a focus on improving general agility, and coordination between the nervous system and muscles when throwing double punch or combinations. Amateur Boxing athletes should also focus on training to improve the reaction time of throwing the right punch and left punch, especially in the case of throwing the left punch, where the result showed that they had the slowest reaction time. Future research studies should focus on additional forms of double punch or combinations, in order to improve the efficiency of combinations that will give Amateur Boxing athletes a competitive edge. This research study was limited to throwing certain forms of punches within a specified area of movement, if the experiment is to be done with the simulated conditions of a real practice or a competitive match then future research studies will be able to produce a different result.

APPLICABLE REMARKS

- Coaches should train Amateur Boxing athletes to improve their reaction time to stimulus, general agility, and coordination of the nervous system and muscles, especially focusing on throwing double punches or combinations to gain a competitive edge.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Nattthaphol Phewkham. Acquisition of data: Nattthaphol Phewkham, Sairag Saadprai. Analysis and interpretation of data: Nattthaphol Phewkham, Nilmanee Sriboon, Sairag Saadprai. Drafting the manuscript: Nattthaphol Phewkham, Nilmanee Sriboon, Sairag Saadprai. Critical revision of the manuscript for important intellectual content: Nattthaphol Phewkham, Nilmanee Sriboon, Sairag Saadprai. Statistical analysis: Nattthaphol Phewkham, Sairag Saadprai. Administrative, technical, and material support: Nattthaphol Phewkham, Nilmanee Sriboon, Sairag Saadprai. Study supervision: Nattthaphol Phewkham, Sairag Saadprai, Nilmanee Sriboon, Tawatchai Ploydang.

CONFLICT OF INTEREST

There is no conflict of interest declared by the authors.

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