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Pamukkale J Sport Sci, 14(1), 83-97, 2023 **Research Article**

Comparison of the Effect of Static and Dynamic Core Exercises on Physical Performance Parameters in Young Boxers

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ABSTRACT

The purpose of this study was to investigate the effects of six weeks of static and dynamic core exercises on physical performance parameters in young boxers. Twenty well-trained young male boxers aged 14-18 years were voluntarily involved in the study. All participants were grouped randomly into dynamic and static core exercise groups. A six-week core exercise training program was performed on static and dynamic core exercise groups. Before and after six weeks of training, young male boxers performed anthropometric measures and physical performance tests, including the Yo-yo intermittent recovery test, 30m sprint test, hexagon agility test, standing long jump, maximum push-up, 30sec sit-ups, sit and reach flexibility tests. After data collection, analyses were conducted using the paired t-test and ANCOVA test. The results indicated that the core exercise training program significantly improved both groups' agility, long jump, muscular endurance, and 30m sprint performance ($p<0.05$). In addition, a significant difference was found in the maximum push-up test scores of the static core exercise group ($p <0.05$). On the other hand, the dynamic core exercise group's aerobic capacity and flexibility tests showed a statistically significant increase ($p<0.05$). As a result, it was determined that 6-week static core exercises were effective on push-ups, speed, agility, standing long jump, sit-ups, and balance, while dynamic core exercises were effective on VO2max, flexibility, sit-ups, balance, standing long jump, agility, and sprint. These findings show that static and dynamic core exercises have positive effects on performance in young boxers, but these exercises have different effects.

INTRODUCTION

Regular athletic training and exercise are one of the best ways to improve physical performance and health. In order to be successful at a sport, technical and tactical training and physical exercise that will develop basic motor skills such as strength, endurance, speed, and agility should be added to the primary training program. Since the fundamental training received in childhood and youth period is the main determinant of future athletic success, performing different exercise programs in young athletes is a very important issue for health and athletic performance (Haga, 2008). In this direction, scientific research has been carried out for many years, and new training methods have been developed to improve the basic motoric skills of athletes. In this respect, core exercises, which provide body balance and stabilization in many branches and thus allow technical skills to be exhibited more flawlessly and more efficiently, are a type of exercise that attracts attention in scientific studies and training practices (Luo et al., 2022).

Nowadays, boxing is a popular performance sport in which the interest of young people is increasing with the increasing number of viewers and international investments. For young boxers who continue their work by aiming for championships in the future, as in other team or individual sports, physical performance and physical capacity are very effective in the results of boxing competitions. In order to perform at a high level, the superior performance of today's boxers is seen as a whole of many physiological, biomechanical, and psychological factors (Savaş, 1998). In particular, the muscular strength level of the core region, which includes the abdominal muscles and back and hip muscles, has a great impact on performance (Blower, 2012).

Core exercises increase muscle strength and balance also are often used in training today because they are exercise methods that keep the spine and hips in balance as well as train many trunk muscles. Strengthening the core muscles is a critical factor for development. It is a training method that accelerates the return of the athlete to the field, increases physical performance, and protects from sports injuries and rehabilitation (Boyaci & Biyikli, 2018). In this respect, core exercises are included in training programs of almost all sports branches based on physical performance. In core training, exercises are performed in two different ways, both static and dynamic (Gür & Ersöz, 2017; Luo et al., 2022). Although there are literature studies reporting that static and dynamic core training is beneficial, experimental studies on their effects on boxers are insufficient. There are studies in which the physical performance parameters of young boxers are measured both nationally and internationally in scientific studies (El Ashker, 2012). Although there are some studies where core exercises are applied to young boxers, there is insufficient information on whether static core exercises or dynamic core exercises are more effective. For this reason, we aimed to present scientific findings to young boxers and their trainers by examining the effects of dynamic and static core exercises on physical performance parameters in young boxers.

METHODS

Research Model

In the study, the pre-test-post-test design from experimental research methods was used. All participants were randomly divided into dynamic (DCEG) and static core exercise groups (SCEG) by unbiased assignment. Both groups were subjected to measurements under equal conditions before and after the experiment. Before the research was conducted, the aims, test protocols, and core exercise program of this research were explained to all boxers and their parents. This study was approved in advance by Çanakkale Onsekiz Mart University Scientific Research Ethics Committee (2100049931 - 2021).

Study Group

A total of twenty well-trained young male boxing players aged 14-18 years with body height 178.7±6.88 cm in SCEG and 177.5±8.59 cm in DCEG, body weight 69.40±7.50 kg in the SCEG and 66.80±14.06 kg in the DCEG voluntarily participated in the study. Participants were both healthy and regularly trained for at least three years, two times a week for about two hours in every training session.

Data Collection Tools

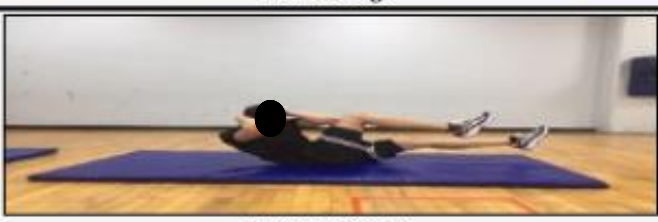
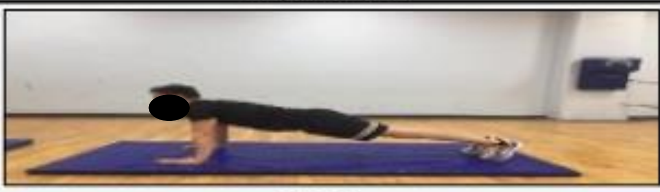
Training Protocol

The SCEG and DCEG consisted of 10 athletes and performed seven core exercises with increased difficulty levels for six weeks after the usual boxing training three days a week. The techniques and important points of the exercises in the training program were taught to all athletes before the training began. The training program and core exercises were determined according to current reference studies. The number of repetitions and times were determined by considering the literature examples (Das, 2017; Gür & Ersöz, 2017; Gür, 2020). Time limits were introduced for static core exercises and repetition/number limits for dynamic core exercises. All movements were performed in three sets. The activities were tried to be done with the right technique, controlled, and slow speed. The resting time between movements is determined as 30 sec, and the resting time between sets is defined as one min. The training programs of the SCEG and DCEG are demonstrated in Figure 1.

Figure 1
Static and Dynamic Core Exercise Training Programmes

Static Core Exercises	Time*Rep		
	1-2 Week	3-4 Week	5-6 Week
 Static Side Plank	30s*3	45s*3	60s*3
 Front Plank	30s*3	45s*3	60s*3
 Lower Up Plank	20s*3	25s*3	30s*3
 Posterior Plank	20s*3	25s*3	30s*3
 Static Squat	20sn*3	30s*3	45s*3
 Superman Arch Body	5s*6x3	10s*6x3	15s*6x3
 Alternate Heel Touch	12*2x3	15*2x3	20*2x3

Figure 1 (Continued)

Dynamic Core Exercises	Time*Rep		
	1-2 Week	3-4 Week	5-6 Week
 Dynamic Side Plunk	15*2x3	20*2x3	25*2x3
 Spiderman Plank	10*2x3	15*2x3	20*2x3
 Crunch With Pushing Hands	10*2x3	15*2x3	20*2x3
 Forward Lunge	8*2x3	10*2x3	12*2x3
 Pulse Lunge	10*2x3	12*2x3	15*2x3
 Bicycle Crunch	10*2x3	12*2x3	15*2x3
 Push Up	12x3	15x3	20x3

Data Collection

Anthropometric measurements; body mass index (BMI), body height, weight, and physical performance tests; Yo-yo intermittent recovery test, standing long jump, hexagon agility, maximum push-up, 30-sec sit-up, flamingo balance, sit and reach flexibility and 30m sprint tests were performed to determine the effect of six-week core training. Pre-and post-anthropometric measurements and physical performance tests were carried out in an indoor sports hall (American College of Sports Medicine, 2013; Ashok, 2008). First, baseline measurements and tests of participants were performed. Following the first measurements, their post-measurements and tests were performed after the six-week static and dynamic core training period. Physical performance tests were performed in the morning and afternoon on the same day. After a standard 10-minute warm-up in the morning session, 30m sprint, flamingo balance, 30-sec sit-up, sit and reach flexibility, and maximum push-up tests were performed two times, respectively. The participants' best test scores were accepted. The yo-yo intermittent recovery test was conducted in the afternoon session. Participants were given five min rest periods between performance tests. According to yo-yo intermittent recovery test results, Bangsbo's formula was used to calculate the estimated VO_{2max} values.

Formula: VO_{2max} (ml.kg–1.min–1) = 36.4 + (0.0084*Running distance) (Bangsbo et al., 2008).

Data Analysis

Statistical analyses were performed using the SPSS statistic software package (version 15.0). Categorical variables were calculated as frequency (n) and percentage (%), while continuous variables were calculated as arithmetic mean (X) and standard deviation (sd). The Shapiro-Wilk W test was used to determine that data was acceptable with regard to homogeneity. As variances showed a normal distribution, Paired t-tests were used for within-group comparisons. An analysis of covariance (ANCOVA) with the pre-test value as the covariate was performed to compare the effects of static and dynamic core training of core training between SCEG and DCEG groups for post-test values. The level of statistical significance was set at $p<0.05$.

RESULTS

The intra-group comparison results of the anthropometric pre- and post-test means of the static and dynamic core exercise groups are presented in Table 1. There were statistically significant differences between the pre-and post-test mean scores. It was found a significant increase in SCEG's body height in the post-test ($t(9) = -3.354$, $p = 0.008$), and significant decreases in the post-test BMI (t(9) = 2.593, p = 0.029) and waist circumference mean scores (t(9) = 2.866, p = 0.019). On the other hand, there was no significant difference between the pre-and post-test mean scores of SCEG's body weight, hip circumference, and waist-hip ratio (p> 0.05). When the pre-and post-test mean scores of DCEG's anthropometrics were compared, it was found that there was no significant difference between their pre-and post-test mean scores in anthropometric measurements (p> 0.05).

Table 1
Comparison of Anthropometric Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Body Weight (kg)	Static	70.30±8.24	69.40±7.50	1.711	0.121
	Dynamic	67.50±16.58	66.80±14.06	0.843	0.421
Height (cm)	Static	177.7±7.16	178.7±6.88	-3.354	**0.008***
	Dynamic	177.1±8.87	177.5±8.59	-1.809	0.104
BMI (kg/m²)	Static	21.10±2.30	20.77±2.32	2.593	**0.029***
	Dynamic	21.36±3.70	21.18±3.12	0.925	0.379
Waist Circumference (cm)	Static	79.20±2.44	76.70±3.02	2.866	**0.019***
	Dynamic	79.40±10.93	78.4±7.53	0.826	0.430
Hip Circumference (cm)	Static	95.20±3.67	94.30±3.74	1.588	0.147
	Dynamic	96.3±8.87	95.6±8.23	0.677	0.515
Waist-Hip Ratio	Static	0.83±0.03	0.81±0.02	1.856	0.096
	Dynamic	0.82±0.41	0.82±0.31	0.217	0.833

*: *p< 0.05*

The intra-group comparison results of the VO_{2max}, 30m sprint, and agility pre- and post-test means of the static and dynamic core exercise groups were presented in Table 2. It was found that there were statistically significant differences between the pre-test and post-test mean scores, including an increase in the maximum oxygen capacity (VO_{2max}) of the DCEG in the last test (t(9) = -2.674, p = 0.025), a decrease in the mean sprint score in the post-test (t(9) = -3.608, p = 0.006), and a decrease in the agility average in the post-test (t(9) = 3.37, p = 0.008). It was determined that there was a significant difference between the pre-and post-test mean scores, including a decrease in the 30m sprint performance (t(9) = -3.118, p = 0.012) and agility (t(9)=5.49, p = 0.00) test averages of SCEG in the post-tests (p> 0.05). When the pre-test and post-test VO_{2max} mean scores of SCEG were compared, it was found that there was no significant difference between the mean scores of the pre-test and post-test (p> 0.05).

Table 2
Comparison of VO_{2max}, 30m Sprint, Agility Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
VO_{2max} (ml. kg–1.min–1)[a]	Static	41.63±2.02	41.72±1.52	-0.193	0.852
	Dynamic	42.27±1.91	43.51±2.63	-2.674	**0.025***
30m Sprint (sec)	Static	4.76±0.25	4.94±0.32	-3.118	**0.012***
	Dynamic	4.65±0.25	4.91±0.25	-3.608	**0.006***
Agility (sec)	Static	14.99±2.51	12.92±1.93	5.493	**0.000***
	Dynamic	14.36±1.10	12.49±147	3.377	**0.008***

**: $p< 0.05$*
[a]*Calculation Formula of VO_{2max} for the groups.*

The intra-group comparison results of the long jump, push-up, and sit-ups pre-test and post-test means of the static and dynamic core exercise groups presented are in Table 3. There were significant differences between SCEG's pre-and post-test mean scores in the maximum push-up ($t(9) = -2.864$, $p = 0.019$), long jump ($t(9) = -2.408$, $p = 0.039$) and 30sec sit-ups ($t(9) = -3.539$, $p = 0.006$) test while there were significant differences between DCEG's pre-test and post-test mean scores in the long jump ($t(9) = -3.681$, $p = 0.005$) and 30 s sit-ups test ($t(9) = -6.107$, $p = 0.000$). However, it was found that there was no statistically significant difference between DCEG's pre-test and post-test mean scores in the maximum push-up test ($p> 0.05$).

Table 3
Comparison of Long Jump, Push-Ups, and Sit-Up Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Long Jump (cm)	Static	171.80±18.90	176.80±21.66	-2.408	**0.039***
	Dynamic	166.50±17.29	191.00±28.55	-3.681	**0.005***
Push-up (Reps) [a]	Static	24.20±15.12	28.60±13.35	-2.864	**0.019***
	Dynamic	30.60±8.99	33.50±9.28	-2.169	0.058
Sit-ups (Reps) [a]	Static	23.10±5.21	28.20±6.01	-3.539	**0.006***
	Dynamic	25.80±4.58	30.60±5.37	-6.107	**0.000***

**: $p< 0.05$*
[a]: *The number of repetitions*

The intra-group comparison results of the balance and flexibility pre-test and post-test means of the static and dynamic core exercise groups were presented in Table 4. There were statistically significant differences between the pre-test and post-test scores. It was found a decrease in the number of balance errors of the DCEG in the post-test (t(9) = 4.611, p = 0.001) and an increase in the mean of flexibility performance of the DCEG in the post-test (t(9)=-2.377 p = 0.041). On the other hand, only a significant decrease in the number of balance errors was determined between the pre-test and post-test mean score in SCEG's flamingo balance test (t(9) = 4.272, p = 0.002). However, it was found that there was no statistically significant difference between the pre-test and post-test mean scores in SCEG's flexibility performance (p> 0.05).

Table 4
Comparison of Balance and Flexibility Measurement Parameters of Training Groups

Variables	Group	Test Time		t	p
		Pre-Test	Post Test		
Balance (number of errors)	Static	7.50±1.90	5.10±1.72	4.272	**0.002***
	Dynamic	8.30±3.33	5.00±2.21	4.611	**0.001***
Flexibility (cm)	Static	29.60±7.26	33.50±9.09	-1.896	0.091
	Dynamic	31.60±9.97	34.30±6.92	-2.377	**0.041***

*: *p< 0.05*

In the study, ANCOVA comparisons of post-test mean scores of SCEG and DCEG made by covariation the groups' pre-test mean scores are presented in tables 5, 6, 7, and 8. Pre-test mean scores of groups were covariates in ANCOVA analyses.

Table 5
Comparison of Anthropometric Measurement Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Body Weight (kg)	69.40±7.50	66.80±14.06	0.145	0.708
Height (cm)	178.7±6.88	177.5±8.59	3.127	0.095
BMI (kg/m²)	20.77±2.32	21.18±3.12	0.985	0.335
Waist Circumference (cm)	76.70±3.02	78.40±7.53	2.588	0.126
Hip Circumference (cm)	94.30±3.74	95.60±8.23	0.091	0.767
Waist-Hip Circumference	0.81±0.02	0.82±0.31	0.819	0.378

In the study, the results of the comparison of the post-test mean scores of SCEG's and DCEG's anthropometric measurements were presented in Table 5. According to the results of the ANCOVA analysis, it was determined that there was no significant difference between the post-test mean scores of groups in the body weight, height, BMI, waist circumference, hip circumference, and waist-hip ratio (p> 0.05).

Table 6
Comparison of VO_{2max}, Sprint, Agility Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
VO_{2max} (mL/kg/min)	41.72±1.52	43.51±2.63	3.794	0.680
30m Sprint (sec)	4.94±0.32	4.91±0.25	0.408	0.532
Agility (sec)	12.92±1.93	12.49±147	0.007	0.934

In the study, the comparison results of the VO_{2max}, speed, and agility post-test score mean of SCEG and DCEG were presented in Table 6. According to the results of the ANCOVA analysis, there was no significant difference between the VO_{2max}, sprint, and agility post-test mean scores of the groups ($p > 0.05$).

Table 7
Comparison of Long Jump, Push-Up, and Sit-Ups Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Long Jump (cm)	176.8±21.66	191.0±28.55	7.772	**0.013***
Push-ups (Rep)	28.60±13.35	33.50±9.28	0.092	0.766
Sit-Ups (Rep)	28.20±6.01	30.60±5.37	0.000	0.992

*: *p< 0.05*

In the study, the comparison results of the long jump, push-up, and sit-up post-test mean scores of SCEG and DCEG were presented in Table 7. According to the results of the ANCOVA analysis, it was determined that there was a significantly higher increase in the long jump performance of DCEG ($f = 7.772$, $p = 0.013$). However, no significant difference was found between the push-ups and sit-ups post-test mean scores of the groups ($p > 0.05$).

Table 8
Comparison of Balance and Flexibility Post-Test Averages of Training Groups

Variable	Group		f	p
	Static	Dynamic		
Balance (number of errors)	5.10±1.72	5.00±2.21	0.502	0.488
Flexibility (cm)	33.50±9.09	34.30±6.92	0.099	0.757

In the study, the results of the comparison of the balance and flexibility post-test mean scores of SCEG and DCEG were presented in Table 8. According to the results of the ANCOVA analysis, there was no significant difference between the balance and flexibility post-test mean scores of the groups ($p > 0.05$).

DISCUSSION

In the study, the findings on the effects of two different core training protocols applied on the anthropometric and physical performance parameters of young boxers were synthesised with literature studies and discussed. It is seen that most of the similar studies in the literature are performed regardless of core exercise practices as dynamic or static. However, it is also known that static and dynamic core exercises have different physiological effects due to mechanical differences. For this reason, the effects of static and dynamic core exercises were examined separately in this study.

In the study, young boxers' body weight, height, body mass index, waist circumference, hip circumference, and waist-hip ratio were examined. In the statistical comparison within the group in the pre-and post-test, it was seen that there was an increase in the mean height of the SCEG and a decrease in the means of BMI and waist circumference. When the literature studies are examined, it is known that static core exercises contribute to muscle development and fat burning, especially in the abdominal region. In the study conducted by Sever (2016), which investigated the effect of dynamic and static core exercise training for 30 min / three days a week in eight weeks on young football players, have been reported that a decrease occurred in the BMI score of players. In this respect, the positive effects of static core exercises around BMI and waist were also seen in this study. However, there was no literature finding that could base the increase in height completely on static core exercises as a result of 6 weeks of exercise. In order to state definitively that this change in height is due to static activities, it is necessary to confirm it with different studies. It may also be coincidental due to the fact that the participants are at a growing age. In addition, in the post-test ANCOVA comparison made by neutralising the pre-tests, it was determined that this difference was not significant compared to the DCEG's mean height values. On the other hand, significant differences in the variables of height, body mass index, and waist measurements are thought to be not only related to core exercises but also play a role in factors such as environmental and genetic factors. When the literature on training practices is examined, it is necessary to consider the growth process when measuring physical performance in children and adolescent athletes (Sağlam et al., 2002). It is thought that there was a significant difference in the body mass index and waist circumference measurements of the static core training group, and this difference was due to the effect of the increase in height. For this reason, it is reported that the height increase of the athletes is 7-12 cm per year in these groups of athletes due to the secretion of growth hormone more in this age, and the increase in the height of the athletes participating in the research is, therefore, an expected normal result (Brown et al, 2017).

In the comparison of findings before and after the core exercises between the groups, it was seen that there were no significant differences in body weight, height, BMI, waist circumference, hip circumference, and waist-hip ratio characteristics of both exercise groups. In the study conducted by Boyacı and Bıyıklı (2018), in which 40 football players aged 11-13 years old, the physical characteristics of 10-week core exercises were examined. Their findings show that there was no statistically significant difference in anthropometric characteristics such as height and body weight before and after training. In general, these findings and our findings are similar. Since the athletes train regularly in groups, their general physical characteristics are in ideal dimensions; therefore, it is thought that there is no significant change in anthropometric measurements as a result of core exercises.

When the intra-group changes of SCEG and DCEG included in our study were examined, physical performance variables VO_{2max}, sprint, agility, long jump, push-ups, sit-ups, balance, and flexibility were analyzed. It is seen that there were positive changes in the sprint and agility performance test durations of the static and dynamic core exercise groups. In addition, it was determined that there was a significant increase in the VO_{2max} performance of DCEG, but no significant change was found in the VO_{2max} performance of SCEG. This difference between the groups is an expected result, as dynamic core exercises positively affect cardiac parameters and aerobic endurance performance, such as interval training applications. Scientific studies have reported that core exercises have a positive effect on agility and sprint performance (Bayrakdar et al., 2020). In the literature, it is stated that the strength of the core muscles contributes to the change-of-direction maneuverability, especially the balance, and the increase in sprint performance (Brull-Muria & Beltran-Garrido, 2021; Başkaya, et al., 2023). In this context, our research revealed that both static and dynamic core exercises cause improvement in both agility and sprint performance. The effect of trunk stability exercises on sportive performance was investigated in the study in which 30 female volleyball and basketball athletes for ten weeks participated. As a result of the study, a significant change occurred in the agility tests in the experimental group (Mills et al., 2005). Another study stated that static core stabilisation exercises in 17 children aged 9-12 years increased their long jump performance (Allen et al., 2014). Considering our study and the literature, it is recommended that static and dynamic core exercises have positive effects on athlete performance in terms of explosive strength and endurance properties. Since strength and endurance are important parameters in performance sports; it is recommended that static and dynamic core exercises be added to the routine training programs of the athletes.

When the intra-group changes of SCEG and DCEG before and after the study were examined, balance performance showed a significant positive change in both groups. On the other hand, positive change in flexibility performance was seen only in the DCEG. When we examined the literature, Samson (2005) investigated the relationship between core exercises and dynamic balance for tennis players with an average age of 20. In the study, 13 athletes were the experimental group, and 15 athletes were in the control group. The effects of 5-week core training have been examined with the Star Excursion Balance Test. As a result of the test, there was a significant change in the dynamic balance characteristic of the experimental group. In another study (Ardali & Gönerer, 2019), the effects of core exercises applied to swimmers between the ages of 10-12, 3 days a week for eight weeks, on the motoric performance of the athletes after the training were examined. When the pre-test and post-test values of the experimental group were compared, they found that there was a significant increase in balance, flexibility, and long jump test measurements. Similarly, Gür and Ersöz (2017) reported that core training had a positive effect on the core strength and balance of tennis athletes aged 8-14 years old. When our study and related literature are examined, static and dynamic core exercises should be added to training programs in order to improve balance and flexibility, which are important parameters for athlete performance.

CONCLUSION

As a result, it was determined that 6-week static core exercises were effective on push-ups, speed, agility, standing long jump, sit-ups, and balance, while dynamic core exercises were effective on VO_{2max}, flexibility, sit-ups, balance, standing long jump, agility, and sprint. This shows that static and dynamic core exercises in young boxers have positive effects on performance in general but these exercises have different positive effects. Accordingly, it is an effective opinion for both static and dynamic core exercises in training practices, and if possible, to have combined core exercises.

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Authors' contributions

All authors carried out the research design together. The first author was involved in the data collection and writing process. The second author took responsibility for data analysis and interpretation of the data, the supervision and critical reviewing of the original draft, as well as the approval of the final draft. All authors contributed to the discussion of the results and the manuscript's preparation.

Conflict of interest declaration

The authors declare that they have no conflict of interest.

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