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The Physical Health and Body Composition of Young Male Indian Rowers, Kayakers and Canoers Following Systematic Training

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Abstract*—The main intention of this study is to find out the significance of specific exercise on body composition and physical health of young Indian male rowers, kayakers and canoers and to find out which training intensity would be suitable for the respective athletes to reach the zenith of their success. The experiment was carried out in the center of Jagatpur, Sports Authority of India on 6 male rowers, 7 male kayakers and 6 male canoers. The stature of the body (cm), the mass of body (kg) and body mass index or, BMI (kg/^{m2}) were calculated with general procedures. Composition of body including mass of fat (FM), fat-free mass (FFM), total body water (TBW), extracellular water (ECW), intracellular water (ICW), the ratio between extra and intracellular water (ECW: ICW), cellular mass of the body (BCM), muscular mass (MM), total calcium of the body (TBCa), glycogen, overall body potassium (TBK), and minerals were assessed using Bioelectrical Impedance Analysis (BIA) with the Maltron Bioscan 920-2 from the UK. The training program for the current research study was divided into three phases: the Pre-competitive Period (PCP), Competitive Period 1 (CP1) and Competitive Period 2 (CP2). The goal of our current study was to examine the impact of training on body composition and health. Group differences were analyzed using one-way analysis of variance (ANOVA) then Schiff`s Post hoc test was performed with Confidence level at p<.01 and p< 0.05. In the case of male rowers' body mass index (BMI kg/^{m2}) has decreased from Precompetitive Period (PCP) to Competitive Period 2 (CP2) at (p<0.01) and body mineral content (kg) has increased significantly at (p<0.05). The ECW %), ECW: ICW and mineral content (kg) of male kayakers has increased significantly from PCP to CP2 at (p<0.05). TBW, MM and mineral content in the case of male canoers were found to be significantly and progressively increased from Precompetitive Period (PCP) to Competitive Period 2 (CP2) at (p<0.05). Analysis of the composition of the body are very much crucial to checking health status of athletes; along with specific training is essential to maintain proper body composition.*

Keywords*— training, body composition, total body water, mineral content, bioelectrical impedance analysis.*

I. INTRODUCTION

Every sport's category requires a certain level of determination from athletes, which is crucial for their success. The physical characteristics and body composition of athletes play a significant role in the competition for rowers, kayakers, and canoers. Consistent and effective training can help maintain the body composition of athletes, making them suitable for their respective sports [1,2]. Competitive rowing involves repetitive muscular movements and places high demands on various aspects of physical fitness, such as cardiorespiratory endurance and muscular strength[3]. Kayaking is a speed-focused sport that emphasizes technique and requires a high level of physical capacity through proper form. Canoeing, on the other hand, is an aerobic endurance sport. Both kayaking and canoeing are technical sports that require a strong body. Understanding the specific physical and body composition requirements of these sports can provide a scientific basis for selecting and training athletes[4]. Rowers face backward in the boat, kayakers face forward, and canoers kneel while facing the front of the boat. Proper estimation of body composition is essential for athletes in these water sports to achieve peak performance levels[5]. Body build varies depending on the type of boat and competition in rowing, kayaking, and canoeing. The primary objective of this study is to assess the impact of training on the body composition and physical health of male rowers, kayakers, and canoers.

II. MATERIALS AND METHODS

Participants:

Six rowers (age = 15.66±1.41 years), seven kayakers (age = 14.9±1.41 years), and six canoeists (age = 15.62±1.85 years) were among the nineteen young males who were taken into consideration for this study. These athletes were all members of the Jagatpur, (Orissa) Sports Authority of India (SAI) Special Area Game scheme (SAG). Every athlete had at least 4-5 years of formal training experience in addition to performing at a state-level. They have the same nutritional profiles, training regimens, and climate, and they are of the same socioeconomic position. They could therefore be referred to as homogenous subject

Training Techniques:

Training schedule for kayakers, canoers, and rowers: Ten to eleven training sessions were completed each week, with one break permitted after every five sessions. Athletes begin their morning workouts at 5:45 am and work out until 9:30 am. Training took place in the evening from 3:30 to 7:00 p.m. They engage in strength training for 45 to 60 minutes in the evening and endurance training for 60 to 80 minutes in the morning. The training schedule is displayed in Table 1.

Intensity is primarily measured in "Heart rate" and is expressed as a percentage of "Maximum Heart rate" with a "Target Zone" indicated. To reach the maximum heart rate, 220 was deducted

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from the athlete's age-related stroke rate. The "Stroke rate" has a unique technical effect and is closely linked to the heart rate. Table 1 provides an overview of the training protocol.

TABLE 1. The training regimen for Rowers, Kayakers and Canoers

Main effect	Categories	Training Phases		
		April to June Pre-competitive period (PCP) Basic Specific Endurance & Rowing/Paddling Technique	July to September Competitive period 1(CP1) Increased Specific Endurance	October to November Competitive period 2 (CP2) "Peak" for the Championships
Volume (minutes/week)	Rowing	686	722	759
	Kayaking	670	700	725
	Canoeing	662	690	712
Distance covered (kilometers)	Rowing	12.5-13	13.5-14.5	15-17
	Kayaking	10-12	12.5-13.5	14-16
	Canoeing	8-9	9.5-10.5	12-14

Physical parameter measurement:

Height (in centimeters): Anthropometer/stadiometer was used to measure it. Weight (in kilograms): A weighing pan was used to take this measurement. BMI, or body mass index (kg/m2). It was examined using this formula: kilos of body weight divided by square meters of height [6].

Calculating the body composition:

By using BIA, multiple body compositions were examined closely. A multi-frequency analyzer was used to assess the total body electrical impedance to an alternative current (0.2 mA) at four different bioelectrical impedance analysis frequencies: 5, 50, 100, and 200 KHz. For all of these, subjects were requested to lie down on a non-conductive surface in the supine position and to relax for five minutes. On the hands and feet (the dorsal surface of the right side of the body), electrodes were affixed to areas that had been cleansed with isopropyl alcohol. Adherence was assured to minimize any potential errors[7].

III. Result

Statistical Program for the Social Sciences or, SPSS, version 26.0 of Chicago, Il, USA was used for statistical analysis. Group differences were analyzed using one-way analysis of variance (ANOVA) then Schiff`s Post hoc test was performed with Confidence level at $p<0.01$ and $p< 0.05$.

Table 2 reveals that in the case of male rowers body mass index (BMI kg/^{m2}) has decreased from Precompetitive Period (PCP) to Competitive Period 2 (CP2) at ($p<0.01$) and body mineral content (kg) has increased significantly at ($p<0.05$).

TABLE 2. Influence of training on body composition and physical health of male rowers

PROFILES	Male Rowers			F VALUE	P VALUE
	Training Phases				
	PCP	CP1	CP2		
Body Height (cm)	175 ±87.04	175.67±86.88	175.9 7±8..52	.062(ns)	.940
Body Weight (kg)	60.5±29.83	59.17±1.89	57.3±1.67	1.739(ns)	.254
BMI (kg/^{m2})	19.63±0.23	19.17±0.06	18.57±0.25	21.444**	.002
Fat-free Mass (kg)	85.7±4.85	88.7±2.49	90.1±2.25	1.308 (ns)	.338
Fat (%)	12.33±2.02	10±2.61	9.33±2.92	1.150(ns)	.378
Total Body Water (liter)	59.6±3.05	63.13±2.28	65.27±1.44	4.437 (ns)	.066
Extracellular Water (%)	31.26±2.73	35.36±6.22	38.43±5.73	1.474(ns)	.301
Intracellular Water (%)	64.17±5.77	68.57±2.63	71.57±3.23	2.460(ns)	.166
ECW/ICW (%)	0.48±0.05	0.58±0.14	0.65±0.14	1.572(ns)	.283
Body Cell Mass(kg)	26.67±2.83	27.96±2.41	30.2±3.50	1.100(ns)	.392
Muscle Mass (kg)	24.37±1.96	27.23±2.58	30.47±4.81	2.492(ns)	.163
Total Body Potassium (gm)	130.1±8.06	139.27±7.56	149.67±10.26	3.792(ns)	.086
Total Body Calcium (gm)	891.33±100.62	926±119.66	1016±211.06	.540(ns)	.609
Glycogen(gm)	453.33±51.07	489±13.11	512.33±11.24	2.734(ns)	.143
Mineral (kg)	3.71±0.64	4.33±0.23	5.55±0.83	6.797*	.029

Values of different variables are shown in (mean ± standard deviation); (*) denotes significant at $p<0.05$; (**) denotes significant at ($p<0.01$) from Precompetitive Phase (PCP) to Competitive Phase 2 (CP2) and (ns) denotes values are not significant

Table 3 reflects that extracellular water (ECF %), extracellular water and intracellular water ratio (ECW/ICW) and mineral content (kg) of male kayakers have increased significantly from PCP to CP2 at $p<0.05$.

Table 4 depicts that total body water, body cell mass, muscle mass, total body potassium and mineral content were significantly and progressively increased from the Precompetitive Period to the Competitive Period at ($p<0.05$).

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TABLE 3 Influence of training on body composition and physical health of male kayakers

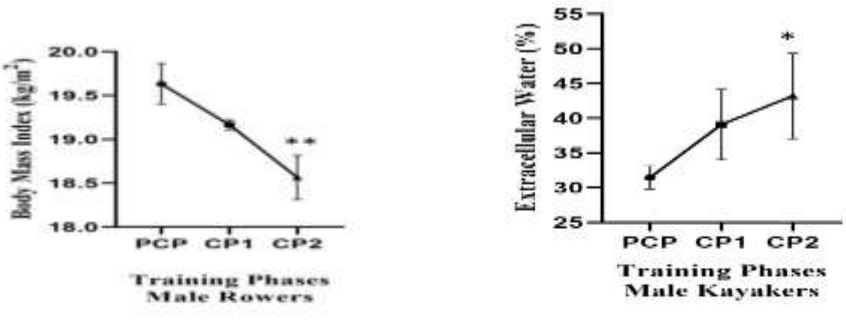
Profiles	Male Kayakers			F VALUE	P VALUE
	Training Phases				
	PCP	CP1	CP2		
Body Height (cm)	173.37±5.73	174.87±6.00	175.3±5.90	0.25(ns)	.976
Body Weight (kg)	68.37±9.04	64.25±5.98	61.45±4.43	1.062(ns)	.385
BMI(kg/^{m2})	23.52±2.70	21.15±2.42	20.11±1.79	2.244(ns)	.162
Fat Free Mass (kg)	85.4±5.14	85.5±2.70	86.17±2.90	.051(ns)	.951
Fat %	15.87±3.62	13.95±3.13	11.9±2.41	1.649(ns)	.245
Total Body Water (TBW) (liter)	57.02±2.70	60.72±5.10	63.47±4.46	2.361(ns)	.150
Extracellular Water (%)	31.45±1.90	39.07±5.83	43.2±7.09	4.844*	.037
Intracellular Water (%)	60.9±5.84	67.12±4.64	69.25±4.23	3.074(ns)	.096
ECW/ICW (%)	0.46±0.40	0.65±0.15	0.72±0.15	4.977*	.035
Body Cell Mass(kg)	28.47±3.04	29.92±2.17	31.9±1.85	2.042(ns)	.186
Muscle Mass (kg)	25.47±3.13	26.82±2.66	29.02±4.32	1.083(ns)	.379
Total Body Potassium (gm)	135.7±14.73	142.52±10.36	151.12±13.15	1.442(ns)	.286
Total Body Calcium (gm)	993.25±95.95	1037.75±67.52	1145.75±165.42	1.794(ns)	.221
Glycogen (gm)	459.5±58.51	498.5±54.00	528.75±61.52	1.429(ns)	.289
Mineral (kg)	3.60±0.69	4.24±0.81	5.22±0.81	4.463*	.045

Values of different variables are shown in (mean ± standard deviation); (*) denotes significant at $p<0.05$; (**) denotes significant at ($p<0.01$) from Precompetitive Phase (PCP) to Competitive Phase 2 (CP2) and (ns) denotes values are not significant.

TABLE 4. Influence of training on body composition and physical health of male canoers

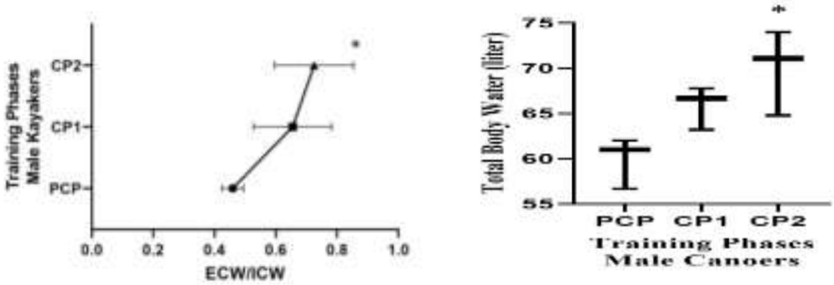
Profiles	Male Canoers			F VALUE	P VALUE
	Training Phases				
	PCP	CP1	CP2		
Body Height (cm)	169.83±2.25	170.43±2.40	170.83±2.25	.143(ns)	.870
Body Weight (kg)	63.73±2.58	61.17±2.47	59.83±2.30	1.959(ns)	.221
BMI (kg/^{m2})	21.7±1.06	21.13±0.93	21.17±1.30	.247(ns)	.789
Fat-free mass	84.5±5.91	89.47±0.81	91.93±0.86	3.551(ns)	.096
Fat (%)	14.8±3.99	11.07±0.15	8.53±2.11	4.379(ns)	.067
Total Body Water (liter)	59.9±2.82	65.97±4.70	69.97±4.70	6.4438*	.032
Extracellular Water (%)	34.2±3.55	38.63±3.36	45.23±7.75	3.300(ns)	.108
Intracellular Water (%)	64.6±5.6	67.13±4.71	70.1±5.90	.772(ns)	.503
ECW/ICW (%)	0.52±0.08	0.62±0.10	0.68±0.13	1.691(ns)	.262
Body Cell Mass(kg)	27.53±0.23	30.4±1.54	33.13±2.77	6.997*	.027
Muscle Mass (kg)	24.67±0.66	27.43±1.01	29.87±2.49	7.933*	.021
Total Body Potassium (gm)	131.2±1.01	145.47±12.10	156.27±12.1	7.224*	.025
Total Body Calcium (gm)	964.33±7.09	1087.67±81.43	1295.33±248.85	3.671(ns)	.091
Glycogen (gm)	457.33±23.86	499±34.12	540±61.83	2.767(ns)	.141
Mineral (kg)	3.59±0.40	4.23±0.35	4.70±0.32	7.263*	.025

Values of different variables are shown in (mean ± standard deviation); (*) denotes significant at ($p<0.05$); (**) denotes significant at ($p<0.01$) from Precompetitive Phase (PCP) to Competitive Phase 2 (CP2) and (ns) denotes values are not significant.



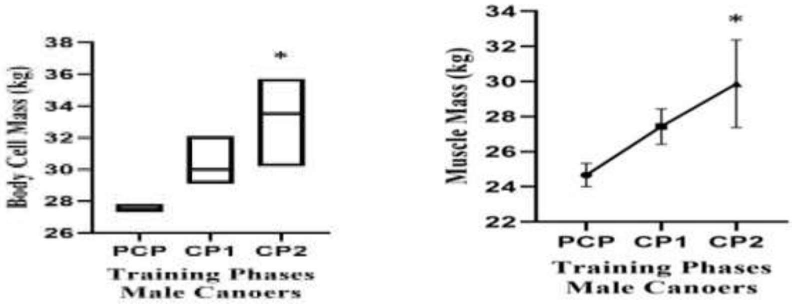
(a) (b)

Figure 1(a-b) Influence of training on body mass index (BMI) of male rowers, (**) denotes significant at ($p<0.01$) and influence of training on extracellular water (ECW) (%) of male kayakers, (*) denotes significant at ($p<0.05$), (values are shown in mean ± standard deviation)



(a) (b)

Figure 2 (a-b) Influence of training on the ratio of extracellular and intracellular water (ECW/ICW) of male kayakers, (*) denotes significant at (p<0.05) and total body water content (liter) of male canoers, (*) denotes significant at (p<0.05), (values are shown in mean standard deviation)



(a) (b)

Figure 3 (a-b) Influence of training on body cell mass (BCM) (kg) of male canoers and muscle mass content (kg) of male kayakers, (*) denotes significance at (p<0.05), (values are shown in mean standard deviation)

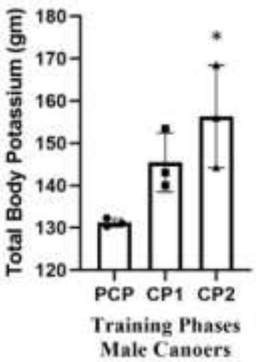
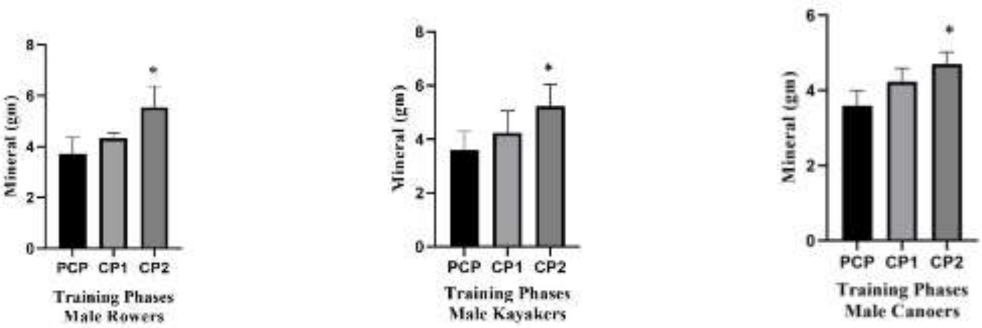


Figure4. Influence of training on total body potassium (TBK) (gm) of male canoers, (*) denotes significant at (p<0.05), (values are shown in mean standard deviation)



(a) (b) (c)

Figure 5 (a-c) Influence of training on mineral content (gm) of male rowers, kayakers and canoers, (*) denotes significance at (p<0.05), (values are shown in mean standard deviation)

IV. Discussion

Human physiology is greatly impacted by body composition and this effect is amplified for athletes who are trained for sports. It also significantly affects athletic performance and abilities. Additionally, it can provide the theoretical underpinnings for scientific athlete selection, scientific training, morphological embellishment, technical and tactical play, and training intensity. Table 2 indicates that the male rowers' body weight (kg) of (57.3±1.67) and body fat percentage (9.33±2.92) were lower than those in the previous study, which had values of 79.2 ± 10.2 and 19.2±7.6, respectively. As indicated in Table 2 and Figure 1(a), the Body Mass Index (kg/m2) (BMI) of our rowers grew considerably and progressively at ($p<0.01$) from the Precompetitive Period (PCP) to the Competitive Period 2 (CP2). It was discovered that our male rowers' BMI was lower than their counterparts. In a water event, nutritional needs and energy expenditure are determined using fat (%) and FFM). No discernible gains in the BF (%) and FFM (kg) of male rowers, kayakers, and canoeists were found in the current study. To perform well as much as possible in a competition, maintaining a healthy BMI is essential[9]. After three training periods, our men rowers' TBW, ECW, ICW, ECW/ICW, TBK, TBCa, and glycogen showed no discernible changes. There is a strong correlation between dehydration and performance in endurance sports. Slater and Tan noted that 1.59% of participants in water racing had dehydration[10]. The total amount of water in the body is important for rowing. The total body water (liter) of the male rowers in our current investigation was discovered to be 65.27±1.44.

Table 2 indicates that the muscle mass (kg) of our male rowers was found to be lower than that of their Turkish counterparts (34.21± 5.98). It has been observed that throughout training, the athletes' lower and upper extremity muscles experience an increase in volume due to muscle hypertrophy, which is necessary for rowing, which demands constant muscular strength and endurance[11]. Table 2 and Figure 5 (a) demonstrate that the mineral content of the male rowers in our current study increased from (3.71±0.64) (PCP) to (5.55±0.83) (CP2) at ($p<0.05$). The force generated in our rower's lumbar spine during the drive phase of rowing is five times their body mass[12]. Therefore, mineral content is a major factor in eminent rowers' physical prowess.

Table 3 shows that the male kayakers in our study had lower body weight (61.45±4.43) and body height (cm) (175.3±5.90) than their overseas counterparts (184.9±5.8) and (78.1±4.9), respectively. The BMI (kg/m2) of 20.11±1.79) is likewise less than that of those equivalents (22.8±0.9). The kayakers in our study had higher total body water (liter) (63.47±4.46), intracellular water (%) (69.25±4.23), and extracellular water (%) (43.25±7.09) than their peers (33.68 ± 2.53), (16.05 ± 1.40), and (0.323 ± 0.010), respectively[13].

The human body is composed of 60% water. 45–65% of total body weight is made up of water. 31% of bones, 79% of muscles, and 73% of the brain are made of body water. Both during the rest and exercise phases, the fluid found in the interstitial spaces carries out numerous crucial functions[14]. During paddling, body water is evacuated, which can cause hypohydration. Hypohydration impairs performance by decreasing blood plasma volume, weakening heart function, blood flow via muscles, and ability to regulate temperature[15]. It is imperative to stay properly hydrated throughout any boating event. Table 3 and Figure 1 (b) demonstrate the considerable rise in extracellular water (ECW %) among male kayakers in our study, from (31.45±1.90) (PCP) to (43.2±7.09) (CP2) at ($p<0.05$). Water found outside of cells offers a steady environment for cellular functions. As indicated in Table 3 and Figure 2(a), the ratio of intracellular to extracellular water has also increased significantly, from (46±0.40) to (0.72±0.15) at ($p<0.05$). As indicated by Table 3 and Figure 5(b), it was discovered that the mineral content of male kayakers increased gradually and considerably from (3.60±0.69) to (5.22±0.81) at ($p<0.05$). For athletes, minerals, proteins, and inorganic salts are essential. They are crucial elements that control how an athlete's body functions physiologically. The absorption and use of nutrients by the body composition are increased by proper training[4].

Table 4 shows that the male participants in our study have lower body height (cm) (170.83±2.25), body weight (kg) (59.83±2.30), and body mass index (kg/m2) than those found in prior studies (176.9 ± 6.9), (75.5 ± 8.0), and (24.1 ± 1.2), respectively. Table 4 and Figure 2(b) demonstrate a significant increase in total body water from (59.9±2.82) to (69.97±4.70) at ($p<0.05$). It was also discovered that the total body water in liters (69.97±4.70) was greater than that of their peers (32.27±4.01) [13]. As indicated in Table 4, in figures 3(a), 3(b), 4 and 5(c), respectively, BCM, muscle mass, TBK, and mineral of male canoers were substantially raised from (59.9±2.82) to (69.97±4.70), from (24.67±0.66) to (29.87±2.49), from (131.2±1.01) to (156.27±12.1), and from (3.59±0.40) to (4.70±0.32), respectively, at ($p<0.05$). Ninety-eight percent of potassium is contained in the body cell mass (BCM), making it one of the most significant intracellular cations[16]. Consuming the right amount of fluids is essential for preventing fluid shortages during sporting events. Proper water and electrolyte balance is essential for blood flow, metabolic processes, and improving athletes' physical performance[17], all of which are strongly supported by the data we currently have. When a kayaker propels water with their left paddle, the majority of the right-side flows ahead as well. When a canoeist completes a stroke, they must bring the paddle forward for the next stroke[18,19].

V. Conclusion

1) Following training, male rowers' BMI (kg/m2) dramatically dropped, weight control is essential for preventing back discomfort and other ailments.
2) Extracellular water (ECW) (%) water serves as a medium for material exchange between cells; in the case of male kayakers, both this and the (ECW/ICW) ratio were shown to be significantly improved.
3) Body sweats to maintain an accurate body temperature throughout training sessions and water events, which also eliminates heat. A more metabolically active cell mass

corresponds to a quicker cell signal in the body. At the time of canoeing, muscle mass (kg) is essential because it generates forces that are applied through the arms and shoulders to propel the boat. Total body potassium, or TbK (grams), is essential for heart health as well as for the healthy operation of muscles and neurons. It was discovered that when it came to male canoers, all these factors were elevated.

4) The chemical components that aid in controlling the body's functions are called minerals. Following training, it was discovered that the mineral (gm) content of all three disciplines had greatly improved. We need to make more adjustments to our training regimens for our athletes to make them perform at their peak shortly.

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Conflict of interest: There are no conflicts of interest for the authors about this study.

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