

*Original Research*

# Comparative Analysis of Exercise Intensity in Taekkyeon Training Movements

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## Abstract

**Background:** Taekkyeon is designated as Korea's Important Intangible Cultural Property No. 76 and listed as a UNESCO intangible cultural heritage. This study aimed to analyze the exercise intensity of Taekkyeon, with a focus on Honjayikhigi ("the movements for practice on their own while moving or in place; the basic movements of Taekkyeon"), Bondaeboegi ("the method of practicing movements that harmoniously connect Taekkyeon's offense and defense movements"), and Majumegigi ("the method of practicing hand and kick movements for offense") training movements, which are components of Taekkyeon. **Methods:** Eleven Taekkyeon instructors were included in this study. The performance of Taekkyeon movements was assessed at Dongguk University in March 2022. During Honjayikhigi, Bondaeboegi, and Majumegigi training movements, heart rates were measured using a polar monitor. For all variables, the means and standard deviations were calculated using descriptive statistics, and a paired sample *t*-test was used to compare the heart rates among Honjayikhigi, Bondaeboegi, and Majumegigi training movements. Statistical significance was set at  $\alpha = 0.05$ . **Results:** The average heart rates during Honjayikhigi, Bondaeboegi, and Majumegigi training movements were  $131.42 \pm 8.85$ ,  $128.53 \pm 8.43$ , and  $126.34 \pm 9.26$  beats/min, respectively. The exercise intensity of Honjayikhigi was significantly higher than that of Majumegigi ( $p = 0.200$ ). In Honjayikhigi, the exercise intensities of Naagamyoegigi ( $p = 0.007$ ) and Mannajungikhigi ( $p = 0.017$ ) were significantly higher than that of Seosoikhigi. In Bondaeboegi, the exercise intensities of Apageury Yeodulmadang and Diaugery Nemandang were not significantly different. In Majumegigi, the exercise intensities of Ikhimsu ( $p < 0.001$ ) and Majuchagi ( $p < 0.001$ ) were higher than that of Majugeori, whereas those of Ikhimsu ( $p = 0.003$ ) and Majuchagi ( $p < 0.001$ ) were higher than that of Maguemgil. The exercise intensities of Ikhimsu ( $p = 0.001$ ) and Majuchagi ( $p < 0.001$ ) were higher than that of Allermegigi. **Conclusions:** Adjusting the training sequence and duration according to Taekkyeon level must be considered when establishing a training program because of the apparent differences in exercise intensity among the training movements. Our findings suggest that a greater training efficacy can be achieved if training levels in each Taekkyeon movement are properly classified and customized for beginners.

**Keywords:** Bondaeboegi; exercise intensity; Honjayikhigi; Majumegigi; Taekkyeon; training

## 1. Introduction

Taekkyeon is designated as Korea's Important Intangible Cultural Property No. 76 and listed as a UNESCO intangible cultural heritage [1]. Despite being a martial art, Taekkyeon possesses a soft and natural character, resembling a dance move, as well as a unique personality that encourages participants not to hurt each other in a competition while accepting attacks as examples. This reflects the fact that Taekkyeon has been handed down through Korean history and contains national ideas. Taekkyeon has recently increased its emphasis on physical training and health promotion; nevertheless, no reports on basic data have been published globally. In general martial arts-related studies, the importance of offence power is emphasized, and Taekkyeon is a traditional martial art that aims for beauty with the concept of martial arts. Therefore, it is judged that the value for globalization is high because Taekkyeon is important in terms of the aesthetics of martial arts [2–6]. Hence, basic research on Taekkyeon should be conducted internation-

ally. Taekkyeon is a sport that potentially exhibits beauty as participants compete because it possesses all characteristics of popular sports such as Taekwondo and judo and contains a martial arts concept [7,8]. After Shinhan Seung, the first human cultural property, registered Taekkyeon as an important intangible cultural property, systematic research has commenced [9]. Studies on Taekkyeon have focused on its traditional nature, philosophy, and humanity, including the popular characteristics of traditional martial arts and the task of popularization [10]; moreover, since 2000, kinematic studies on this topic have begun to emerge. Previous studies have reported on the exercise intensity of Taekkyeon according to stepping speed [11] as well as that of Gibongeori (basic leg skills practice), a Taekkyeon component [12]. Additionally, an analysis of muscle activity according to Taekkyeon proficiency during the kicking motion has been conducted [13]. However, no study has reported on the exercise intensity of each Taekkyeon training movement [14]. Although the exercise intensity of the component



**Table 1. General characteristics of the participants (n = 11).**

Age (years)	Height (cm)	Weight (kg)	Body fat (%)	Resting heart rate (beats/min)	VO <sub>2</sub> max (mL/kg/min)	Length of Taekkyeon career (years)
37.45 ± 6.58	173.65 ± 4.21	76.65 ± 9.02	19.38 ± 4.05	73.27 ± 6.90	41.97 ± 6.45	16.45 ± 4.44

Data are expressed as mean ± standard deviation.

training movements is important to the composition of the Taekkyeon training program, reports on this topic are lacking to date. Therefore, the present study aimed to compare and analyze the movement intensities of Honjayikhigi (“the movements for practice on their own while moving or in place; the basic movements of Taekkyeon”), Bondaeboegi (“the method of practicing movements that harmoniously connect Taekkyeon’s offense and defense movements”), and Majumegigi (“the method of practicing hand and kick movements for offense”), which constitute the basic stages of the Taekkyeon training process. This study analyzed the exercise intensity of Taekkyeon according to training movements in order to provide basic data to Taekkyeon trainees and to expand the knowledge base about Taekkyeon.

## 2. Materials and Methods

### 2.1 Participants

The study participants included 11 male instructors (black belt level which is called *Dong*) from the Taekkyeon National Training Center (Important Intangible Cultural Property No. 76) in Korea. The participants’ performance of Taekkyeon movements was assessed at Dongguk University in March 2022. The purpose of this study and the content of the experiment were explained to the participants, who subsequently provided written informed consent prior to study commencement.

### 2.2 Measurements

#### 2.2.1 Physical Characteristics

The participants’ height was measured in centimeters using an anthropometer (HC-1500, CAS, Seoul, Korea), and the weight and body fat percentage (%) were measured using a bioelectrical impedance analysis device (InBody 3.0, BioSpace, Seoul, Korea) [15]. The participants’ physical characteristics are summarized in Table 1.

#### 2.2.2 Maximum Oxygen Uptake (VO<sub>2</sub>max)

Upon arrival in the exercise-load test room, the participants received an explanation regarding the purpose of the experiment and details of the experimental method and signed a consent form. In addition, after a simple warm-up exercise, the participants were equipped with a gas analyzer (Quark b2, COSMED, Albano Laziale, Italy), and an incremental maximum kinetic load test was performed on a treadmill (MT-4000, SNS Care Co., Ltd., Korea) according to the Bruce protocol [16]. The initial exercise load entailed a slope of 10% and a speed of 1.7 mph for 3 min,

which were increased by 2% and 0.8–0.9 mph every 3 min, respectively. Exercise intensity was increased by approximately 2–3 metabolic equivalents in a step-by-step manner, and increments continued until the participants could no longer proceed with the assessment [16].

#### 2.2.3 Measurement of Heart Rate

A Polar heart rate analyzer (RS800, Polar, Finland) was used to measure the heart rate during the Taekkyeon training program. The heart rate measurement equipment was set to a maximum heart rate of 220 beats/min and a minimum heart rate of 60 beats/min, and the heart rate was recorded at 5 s intervals. Each participant in this experiment wore a measuring device, rested for 30 min before measurement, and had their heart rate measured during stabilization and while performing Honjayikhigi, Bondaeboegi, and Majumegigi training movements.




### 2.3 Experimental Procedure

Upon entering the Taekkyeon training center at Dongguk University, each participant wore a heart rate meter, sat on a chair, rested for 5 min, and had their heart rate recorded while performing the Honjayikhigi movement before taking a 10 min break, after which they sequentially performed the Bondaeboegi and Majumegigi movements, which were also separated by a 10 min break. The participants were asked to perform Taekkyeon movements at the same usual speed and to take timed practice runs of each training movement in advance. Following the completion of measurements, the participants had sufficient recovery time.

### 2.4 Taekkyeon Training Program

The Taekkyeon training program was selected as a basic training course. Honjayikhigi comprised Seoseoikhigi (to stand in place and practice hand and foot movements), Naagamyoikhigi (practicing hand and foot movements while moving the body), and Mannajungikhigi (hand and foot skills practiced as the last step). In contrast, Bondaeboegi consisted of Apegeori Yeodulmadang (actions designed to link attack and defense skills and practice training skills on their own in eight different formats) and Duyegeori Nemadang (actions designed to link attack and defense skills and practice training skills on their own in four different formats). Finally, Majumegigi comprised Majugeori (leg skills to practice against another person), Maguemjil (the action of practicing defensive skills against each other), Allermegigi (the action of attacking an opponent with a leg), Ikhimsu (the action of practicing how to attack an op-

**Table 2. Taekkyeon program.**

Training program	Example movement	Sub-program (number of movements: time)	Total running time
Honjayikhigi		Seoseoikhigi (28 movements: 5 min 20 s) Naagamyoikhigi (20 movements: 3 min 55 s) Mannajungikhigi (10 movements: 3 min 10 s)	12 min 25 s
Bondaeboegi		Apegeori Yeodulmadang (8 phase movements: 2 min 45 s) Duyegeori Nemadang (4 phase movements: 2 min 00 s)	4 min 45 s
Majumegigi		Majugeori (7 movements: 3 min 40 s) Maguemjil (9 movements: 3 min 10 s) Allermegigi (14 movements: 3 min 50 s) Ikhimsu (18 movements: 6 min 10 s) Majuchagi (2 movements: 1 min 20 s)	18 min 10 s

**Table 3. Heart rate (exercise intensity) in the training program.**

Training program	Variables		Sub-variables			
	Honjayikhigi	Seoseoikhigi	Naagamyoikhigi	Mannajungikhigi		
Heart rate (beats/min)	131.42 ± 8.85	128.42 ± 8.66	133.65 ± 10.14	133.92 ± 9.28		
Training program	Bondaeboegi		Apegeori Yeodulmadang		Duyegeori Nemadang	
Heart rate (beats/min)	128.53 ± 8.43		127.69 ± 8.72		129.84 ± 8.90	
Training program	Majumegigi	Majugeori	Maguemjil	Allermegigi	Ikhimsu	Majuchagi
Heart rate (beats/min)	126.34 ± 9.26	121.28 ± 8.51	120.88 ± 10.37	122.99 ± 8.34	131.48 ± 11.44	136.01 ± 9.81

Data are expressed as mean ± standard deviation.

ponent), and Majuchagi (the action of attacking each other with a kick). The specific training program is presented in Table 2.

### 2.5 Statistical Analysis

The sample size was determined by performing one-way analysis of variance using G\*Power software version 3.1.9.7 (Heinrich Heine University, Düsseldorf, Germany) to obtain the optimal power (1-beta) and significance level ( $p < 0.05$ ) [17]. Statistical analyses were conducted using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). For all variables, the means and standard deviations were calculated using descriptive statistics, and a paired sample *t*-test was used to compare the heart rates among Honjayikhigi, Bondaeboegi, and Majumegigi training movements. Statistical significance was set at  $\alpha = 0.05$ .

## 3. Results

The heart rate was measured, and the results of the Honjayikhigi, Bondaeboegi, and Majumegigi training movements are presented in Table 3. The entire Honjayikhigi exercise lasted for 12 min 25 s, with an average heart rate of  $131.42 \pm 8.85$  beats/min. During the Honjayikhigi exercise, Seoseoikhigi lasted for 5 min 20 s (average heart rate:  $128.42 \pm 8.66$  beats/min), Naagamyoikhigi lasted for 3 min 55 s (average heart rate:  $133.65 \pm 10.14$

beats/min), and Mannajungikhigi lasted for 3 min 10 s (average heart rate:  $133.92 \pm 9.28$  beats/min).

The entire Bondaeboegi exercise lasted for 4 min 45 s, with an average heart rate of  $128.53 \pm 8.43$  beats/min. During the Bondaeboegi exercise, Apegeori Yeodulmadang lasted for 2 min 45 s (average heart rate:  $127.69 \pm 8.72$  beats/min), and Duyegeori Nemadang lasted for 2 min (average heart rate:  $129.84 \pm 8.90$  beats/min).

The entire Majumegigi exercise lasted for 18 min 10 s, with an average heart rate of  $126.34 \pm 9.26$  beats/min. During the Majumegigi exercise, Majugeori lasted for 3 min 40 s (average heart rate:  $121.28 \pm 8.51$  beats/min), Maguemjil lasted for 3 min 10 s (average heart rate:  $120.88 \pm 10.37$  beats/min), Allermegigi lasted for 3 min 50 s (average heart rate:  $122.99 \pm 8.34$  beats/min), Ikhimsu lasted for 6 min 10 s (average heart rate:  $131.48 \pm 11.44$  beats/min), and Majuchagi lasted for 1 min 20 s (average heart rate:  $136.01 \pm 9.81$  beats/min).

In the Honjayikhigi training movement, a significant difference was observed between Seoseoikhigi and Naagamyoikhigi ( $p = 0.007$ ) and between Seoseoikhigi and Mannajungikhigi ( $p = 0.017$ ). However, no significant difference was observed between Naagamyoikhigi and Mannajungikhigi (Table 4).

In the Bondaeboegi training movement, the difference in heart rate was not significant between Apegeori Yeodul-

**Table 4. Differences among Honjayikhigi's Seoseoikhigi, Naagamyoikhigi, and Mannajungikhigi.**

Honjayikhigi (heart rate, beats/min)	<i>t</i>	<i>p</i>
Seoseoikhigi (128.42 ± 8.66) vs. Naagamyoikhigi (133.65 ± 10.14)	-3.341	0.007**
Seoseoikhigi (128.42 ± 8.66) vs. Mannajungikhigi (133.92 ± 9.28)	-2.870	0.017*
Naagamyoikhigi (133.65 ± 10.14) vs. Mannajungikhigi (133.92 ± 9.28)	-0.336	0.744

Data are expressed as mean ± standard deviation.

\**p* < 0.05, \*\**p* < 0.01, tested using the paired sample *t*-test.

**Table 5. Differences between Bondaeboegi's Apegeori Yeodulmadang and Duyegeori Nema dang.**

Bondaeboegi (heart rate, beats/min)	<i>t</i>	<i>p</i>
Apegeori Yeodulmadang (127.69 ± 8.73) vs. Duyegeori Nema dang (129.84 ± 8.90)	-1.118	0.262

Data are expressed as mean ± standard deviation.

Tested using the paired sample *t*-test.

**Table 6. Differences among Majumegigi's Majugeori, Maguemjil, Allermegigi, Ikhimsu, and Majuchagi.**

Majumegigi (heart rate, beats/min)	<i>t</i>	<i>p</i>
Majugeori (121.28 ± 8.51) vs. Maguemjil (120.88 ± 10.37)	0.196	0.848
Majugeori (121.28 ± 8.51) vs. Allermegigi (122.99 ± 8.34)	-1.238	0.244
Majugeori (121.28 ± 8.51) vs. Ikhimsu (131.48 ± 11.44)	-5.197	<0.001***
Majugeori (121.28 ± 8.51) vs. Majuchagi (136.06 ± 9.82)	-6.997	<0.001***
Maguemjil (120.88 ± 10.37) vs. Allermegigi (122.99 ± 8.34)	-1.379	0.198
Maguemjil (120.88 ± 10.37) vs. Ikhimsu (131.48 ± 11.44)	-3.802	0.003**
Maguemjil (120.88 ± 10.37) vs. Majuchagi (136.06 ± 9.82)	-6.103	<0.001***
Allermegigi (122.99 ± 8.34) vs. Ikhimsu (131.48 ± 11.44)	-4.934	0.001**
Allermegigi (122.99 ± 8.34) vs. Majuchagi (136.06 ± 9.82)	-6.345	<0.001***
Ikhimsu (131.48 ± 11.44) vs. Majuchagi (136.06 ± 9.82)	2.084	0.064

Data are expressed as mean ± standard deviation.

\*\**p* < 0.01, \*\*\**p* < 0.001, tested using the paired sample *t*-test.

**Table 7. Differences among Honjayikhigi, Bondaeboegi, and Majumegigi training movements.**

Heart rate (beats/min)	<i>t</i>	<i>p</i>
Honjayikhigi (131.42 ± 8.85) vs. Bondaeboegi (128.35 ± 8.43)	2.140	0.058
Honjayikhigi (131.42 ± 8.85) vs. Majumegigi (126.34 ± 9.26)	2.758	0.020*
Bondaeboegi (128.35 ± 8.43) vs. Majumegigi (126.34 ± 9.26)	1.026	0.329

Data are expressed as mean ± standard deviation.

\**p* < 0.05, tested using the paired sample *t*-test.

madang and Duyegeori Nema dang (Table 5).

In the Majumegigi training movement, there were statistically significant differences between Majugeori and Ikhimsu (*p* < 0.001), Majugeori and Majuchagi (*p* < 0.001), Maguemjil and Ikhimsu (*p* = 0.003), Maguemjil and Majuchagi (*p* < 0.001), Allermegigi and Ikhimsu (*p* = 0.001), and Allermegigi and Majuchagi (*p* < 0.001). Contrarily, no statistically significant differences were identified between Majugeori and Maguemjil, Majugeori and Allermegigi, Maguemjil and Allermegigi, and Ikhimsu and Majuchagi (Table 6).

There was a statistically significant difference between the Honjayikhigi and Majumegigi training movements (*p* = 0.020); however, no significant differences were observed between Honjayikhigi and Bondaeboegi and between Majumegigi and Bondaeboegi (Table 7).

## 4. Discussion

In the present study, exercise intensity was compared and analyzed among three Taekkyeon training movements (namely, Honjayikhigi, Bondaeboegi, and Majumegigi) by measuring the heart rate. The heart rate represents the frequency of cardiac contractions and is influenced by various factors such as sex, age, temperature, altitude, training, and mental tension [18]. In addition, the heart rate is closely related to circulation during respiratory exercise [19], and physiological indicators, such as the rating of perceived exertion, oxygen intake, and heart rate, are useful in actual field exercise scenarios. Exercise intensity among various sports can be considered an important factor in many aspects, such as the training plan and physical-fitness arrangement for the activity. Measurement methods widely used as objective indicators of exercise intensity include

%VO<sub>2</sub>max and heart rate [20,21]. When interpreting exercise intensity, %HRmax is preferably used and is converted to a relative value in terms of objectivity and validity because the heart rate itself also differs among individuals with respect to stability and maximum value [22].

Regarding overall training movements, Honjayikhigi resulted in a statistically significantly higher heart rate than Majumegigi. Majumegigi is an opponent-engagement activity, thus justifying its higher exercise intensity than those of Honjayikhigi and Bondaeboegi. These results are potentially attributable to three main causes. First, the Majumegigi exercise comprises low-intensity movements in the form of Pumbalgi (the action of practicing the steps for attack and defense in place) until the opponent uses attack or defense skills. In Majugeori, the heel is slightly lifted from the floor; in Maguemjil, one moves back one step at a time to Pumbalgi; in Allermegigi, the body is shaken left and right to perform Pumbalgi; and in Ikhimsu, Pumbalgi is performed freely. Second, Taekkyeon's Majumegigi movement is gentle and uses instantaneous force. Despite being an opponent-based activity, high exercise intensity is unnecessary because it uses instantaneous force when striking the opponent or scattering the opponent's center. Third, Majumegigi involves few repetitions. It uses one technique at a time, maintains the Pumbalgi, and subsequently repeats the technique once. In contrast, Honjayikhigi includes a short break during practice because the participants continue repeating the same movement [23].

On comparing heart rate in each training movement in Honjayihigi, Naagamyokhigi and Mannajungikhigi had statistically significantly higher heart rates than Seoseoikhigi. These results demonstrate that Seoseoikhigi comprises body movements without movement in place, Naagamyokhigi uses hands and feet together while walking, and Mannajungikhigi exhibits relatively high exercise intensity because it comprises complex movements [24]. In Bondaeboegi, no difference in average heart rate between Apegeori Yeodulmadang and Duyegeori Nemandang was observed. Because regular attacks and defenses comprise similar movements, exercise intensity is similar between Apegeori Yeodulmadang and Duyegeori Nemandang [25]. In the Majumegigi training movement, the average heart rates of Ikhimsu and Majuchagi were significantly higher than that of Majugeori, and those of Ikhimsu and Majuchagi were significantly higher than that of Maguemjil. In addition, the average heart rates of Ikhimsu and Majuchagi were significantly higher than that of Allermegigi.

Maguemjil comprises movements that involve the pairing up of two people alternately attacking one another and defending themselves, and skills learning can occur during practice. Because opposing participants can be trained in movements involving alternate attack and defense under mutual consent, accurate and gradual training practices are desirable. Majugeori is a technical training that allows the opponent to trip over the opponent's leg

while pushing their right knee against the other. It is a movement that requires considerable concentration because a participant attacks using the strengths and weaknesses of the other person's physique and central body movement. Allermegigi comprises attack technology-oriented movements, involves movement with opponents' arms together, and uses foot movements to avoid attacks and counter attacks.

Ikhimsu is a training movement for learning Daegeri and Matsseogi skills and is a dynamic technical training that prepares participants for actual situations [26]. Majuchagi is a training course that potentially provides training in all kick movements and requires power and endurance. Improving the accuracy and adjusting the distance of kick attacks by alternately attacking and defending the opponent is essential so that they can become useful in practice [27]. Therefore, as is evident from the composition and characteristics of Majumegigi at each stage, Ikhimsu and Majuchagi comprise movements with relatively higher exercise intensity than those of Majugeori, while Ikhimsu and Majuchagi comprise movements with higher exercise intensity than those of Allermegigi. As these findings were observed in "Master of Taekkyeon" trainees with considerable experience in Taekkyeon training at a highly technical level, classifying different exercise intensities for the general public is considered desirable. In particular, the formulation of a "beginner stage" Taekkyeon training program is warranted.

This study has certain limitations. First, because the sample size was limited to the transferors of the Taekkyeon State, generalization of findings to all Taekkyeon trainees is limited. Second, we analyzed exercise intensity in individuals who are proficient in Taekkyeon rather than that in the general population. Third, women were not included in this study, thus further limiting the generalizability of the study findings. Therefore, well-designed studies that include both sexes are warranted in the future. Fourth, the resting periods between the subsequent exercises are too short for a full recovery and were not randomly assigned so we can expect that the sequence of exercises could influence the results. Furthermore, in order to analyze the general exercise intensity of Taekkyeon, a comparative study should be conducted annually by measuring the heart rate during the regular training of Taekkyeon national trainees. In addition to investigating Honjayikhigi, Bondaeboegi, and Majumegigi training movements, which are the basic Taekkyeon training movements, an analysis of exercise intensity during actual training at the training center is necessary, and continuous research for the globalization of Taekkyeon is warranted. Moreover, the efficacy of training sessions at the Taekkyeon training center may be improved if the training levels for each Taekkyeon movement are appropriately classified and customized for beginners. Nevertheless, this study potentially bears a high level of significance because it (1) is the first international report on

Taekkyeon and (2) contributes valuable information to the literature, as its findings reveal the relative exercise intensities of key Taekkyeon movements—namely, Honjayikhigi, Bondaeboegi, and Majumegigi training movements.

## 5. Conclusions

This study showed that Taekkyeon's Honjayikhigi, Bondaeboegi, and Majumegigi training movements are potentially moderate-intensity exercises. Due to this observed level of exercise intensity, (1) the body movements and attack/defense involved during opponent engagement and (2) the body movements during up-and-down kicking of the opponent are all expected to increase the heart rate during basic movements. When jumping higher and kicking the opponent are involved, the dynamic use of all body muscles is anticipated. Therefore, modification of Taekkyeon exercise duration and intensity according to trainee level and extent of participation in each training exercise is necessary; moreover, more specific and scientific training methods should be developed in subsequent studies.

## Author Contributions

SJ and W-YS designed the research study and methodology. SJ and W-YS provided software. DS contributed to formal analysis. DS contributed to resources and data curation. SJ and W-YS contributed to data curation. SJ and W-YS wrote the manuscript. DS revised the manuscript. SJ and W-YS contributed to visualization. SJ and W-YS supervised the study. DS were in charge of project administration. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

The study protocol was approved by the Ethics Committee of Dongguk University of Korea (approval number: 20220003) and conformed to the standards set by the latest revision of the Declaration of Helsinki. All study participants provided written informed consent.

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## Conflict of Interest

The authors declare no conflict of interest. W-YS is serving as one of the Editorial Board members and Guest editors of this journal. We declare that W-YS had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Davor Plavec.

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