Revista de Artes Marciales Asiáticas
Volume *20*(1), 116-125 ~ January-June 2025
DOI: 10.18002/rama.v20i1.2508
http://revpubli.unileon.es/ojs/index.php/artesmarciales

RAMA
I.S.S.N. 2174-0747

Intermittent *ne-waza* exercise leads to greater effort in *uke* compared to *tori* in prepubescent judo athletes

Bayram CEYLAN[1*], Furkan ÖZTÜRK[2], Hasan Basri TASKIN[1,3], Uğur SARIKAYA[4], & Şükrü Serdar BALCI[5]

[1] *Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University (Türkiye)*

[2] *Department of Coaching Education, Faculty of Sport Sciences, Düzce University (Türkiye)*

[3] *Movement and Training Sciences, Department of Coaching Education, Health Sciences Institution, Kastamonu University (Türkiye)*

[4] *Department of Physical Education and Sport, School of Physical Education and Sport, Harran University (Türkiye)*

[5] *Department of Coaching Education, Faculty of Sport Sciences, Selçuk University (Türkiye)*

Received: 16/11/2025; Accepted: 05/05/2025; Published: 09/05/2025

ORIGINAL PAPER

Abstract

This study investigated physiological and perceptual responses between *uke* (the athlete receiving a technique) and *tori* (the athlete executing a technique) during intermittent *osaekomi-waza* exercises in prepubescent judo athletes. Fifteen child judo athletes (age: 10.8 ± 1.1 years) participated voluntarily. In this cross-over design with randomization (except for the first visit), athletes completed three sessions: anthropometric measurements and familiarization, followed by intermittent *osaekomi-waza* exercises as both *uke* and *tori*. The exercise protocol consisted of four sets of 20-second intermittent *osaekomi-waza* using *kesa-gatame*, interspersed with 10-second rest intervals (1:½ work-to-rest ratio), performed on separate days. Heart rate (HR) was measured at rest, immediately after exercise, and one minute after exercise. The rating of perceived exertion (RPE) was assessed using a 0–10 scale immediately after each exercise bout. While a two-way repeated measures ANOVA indicated a statistically significant main effect of role on HR, with higher values in the *uke* role compared to the *tori* role across all measurement times, Bayesian analysis did not provide substantial evidence supporting this role effect. Athletes also reported significantly higher RPE scores in the *uke* role than in the *tori* role, indicating greater perceptual demands in prepubescent judo athletes, despite similar heart rate patterns between roles.

Keywords: Martial arts; combat sports; judo; young athletes; high-intensity intermittent exercise; HIIT; ne-waza.

El ejercicio *ne-waza* intermitente exige un mayor esfuerzo a *uke* que a *tori* en atletas prepúberes de judo

Resumen

Este estudio investigó las respuestas fisiológicas y perceptivas entre *uke* (el atleta que recibe una técnica) y *tori* (el atleta que ejecuta una técnica) durante ejercicios intermitentes de *osaekomi-waza* en atletas prepúberes de judo. Quince judokas (edad: 10,8 ± 1,1 años) participaron voluntariamente en el estudio. En este ensayo cruzado aleatorizado (excepto en la primera visita), los atletas completaron tres sesiones: mediciones antropométricas y familiarización, seguidas de ejercicios

O exercício intermitente *ne-waza* exige mais esforço do *uke* do que do *tori* em atletas de judo pré-púberes.

Resumo

Este estudo investigou as respostas fisiológicas e perceptivas entre *uke* (o atleta que recebe uma técnica) e *tori* (o atleta a executar uma técnica) durante exercícios intermitentes de *osaekomi-waza* em atletas de judo pré-púberes. Quinze judocas (idade: 10,8 ± 1,1 anos) participaram voluntariamente no estudo. Neste ensaio aleatório cruzado (exceto na primeira visita), os atletas realizaram três sessões: medidas antropométricas e familiarização, seguidas de exercícios intermitentes de

[*] *Corresponding author*: Bayram Ceylan (bceylan@kastamonu.edu.tr)

Contributions: Bayram Ceylan (ACEJLN), Furkan Öztürk (BEM), Hasan Basri Taskin (ABEFM), Uğur Sarikaya (BEM), Şükrü Serdar Balci (ACEFJLN). Codes according to CRediT (Contributor Roles Taxonomy): (A) Conceptualization. (B) Data curation. (C) Formal Analysis. (D) Funding acquisition. (E) Investigation. (F) Methodology. (G) Project administration. (H) Resources. (I) Software. (J) Supervision. (K) Validation. (L) Visualization. (M) Writing – original draft. (N) Writing – review & editing.

Funding: The authors received no funding for this work.

Conflicts of interest: The authors declare no conflicts of interest.

intermitentes de *osaekomi-waza* como *uke* y *tori*. El protocolo de ejercicios consistió en cuatro series de *osaekomi-waza* intermitente de 20 segundos utilizando la técnica *kesa-gatame*, intercaladas con intervalos de descanso de 10 segundos (relación trabajo-descanso de 1:½), realizadas en días separados. Se midió la frecuencia cardiaca (FC) en reposo, inmediatamente después del ejercicio y un minuto después. El esfuerzo percibido (RPE) se evaluó utilizando una escala de 0-10 inmediatamente después de cada ejercicio. Aunque la ANOVA de medidas repetidas de dos vías indicó un efecto principal estadísticamente significativo del rol sobre la FC, con valores más altos en *uke* que en *tori* en todos los tiempos de medición, el análisis bayesiano no proporcionó pruebas sustanciales que apoyaran este efecto del rol. Los atletas también informaron de puntuaciones de RPE significativamente más altas como *uke* que como *tori*, lo que indica una mayor exigencia percibida, a pesar de que los patrones de frecuencia cardiaca en ambos roles fueron similares.

Palabras clave: Artes marciales; deportes de combate; judo; atletas jóvenes; ejercicio intermitente de alta intensidad; HIIT; ne-waza.

osaekomi-waza como *uke* e *tori*. O protocolo de exercício consistiu em quatro séries de 20 segundos de *osaekomi-waza* intermitente usando a técnica *kesa-gatame*, intercaladas com intervalos de descanso de 10 segundos (1:½ relação trabalho/repouso), realizadas em dias separados. A frequência cardíaca (FC) foi medida em repouso, imediatamente após o exercício e um minuto após o exercício. A perceção do esforço (RPE) foi avaliada utilizando uma escala de 0-10 imediatamente após cada exercício. Embora uma ANOVA de medidas repetidas de duas vias tenha indicado um efeito principal estatisticamente significativo do papel na FC, com valores mais elevados no papel de *uke* em comparação com o papel de *tori* em todos os momentos de medição, a análise Bayesiana não forneceu provas substanciais que apoiassem este efeito de papel. Os atletas também relataram pontuações RPE significativamente mais elevadas no papel de *uke* do que no papel de *tori*, indicando uma maior exigência percebida, embora os padrões de frequência cardíaca em ambos os papéis fossem semelhantes.

Palavras-chave: Artes marciais; desportos de combate; judo; jovens atletas; exercício intermitente de alta intensidade; HIIT; ne-waza.

1. Introduction

Judo is an Olympic grappling sport with a high intensity intermittent nature (Ceylan & Balci, 2018; Marcon et al., 2010). Judo contests have a complex structure that includes different phases such as *kumi-kata* (grappling), throwing technique trials, standing struggle, transitions from standing to ground techniques, immobilizing, joint-locking and choking techniques on the ground accompanied with pauses with the referee's command (Franchini, Artioli, & Brito, 2013; Miarka et al., 2014).

Judo contests consist of intermittent loads ranging from 2:1 to 3:1 work to rest ratios (Barreto, Miarka, et al., 2022; Franchini, Takito, & Calmet, 2013; Miarka et al., 2012) and contest duration can vary according to weight categories (Barreto, Aedo-Muñoz, et al., 2022). Rest phases can occur between *matte* (stop) and *hajime* (start) commands, when the referee gives *shido*, during the time until the start of *kumi-kata*, and/or when the position is analyzed with video review (Franchini, Takito, & Calmet, 2013; Kons et al., 2021). Intermittent exercises similar to work to rest ratios during official judo matches have been widely used in previous studies (Da Silva et al., 2021; Zhang et al., 2024).

The high intensity actions occur in the *nage-waza* (throwing techniques) and *katame-waza* (grappling techniques) combats. It has been observed that judo athletes spend more time in *nage-waza* than *katame-waza* during the contest (Miarka et al., 2014; Miarka et al., 2012; Witkowski et al., 2012). However, the new rules allow more time for *katame-waza* struggle (Agostinho & Franchini, 2021; Boguszewski, 2016). During the 2016 Rio Olympic Games, the athletes' rate of winning a contest with *katame-waza* techniques were higher compared to *nage-waza* techniques (Boguszewski, 2016), and at the 2020 Tokyo Olympics, medal-winning athletes had a greater variety of *katame-waza* techniques that led to more scores than non-medal winners (Kons et al., 2022).

Osaekomi-waza is reported to be the most effective technique group in *katame-waza* with high success ratio and many high-level contests are reported to end with *osaekomi-waza* (Adam et al., 2016; Boguszewski, 2016; Witkowski et al., 2012). It was stated that senior, junior and cadet judo athletes who won medals at the World Championships in 2018-2019 scored the most with *osaekomi-waza* (Agostinho & Franchini, 2021). For this reason, coaches and athletes should include *katame-waza* techniques in the training sessions (Boguszewski, 2016). Furthermore, both coaches and athletes concurred that *osaekomi-waza* exercises are of paramount importance to judo training (Weldon et al., 2024). Coaches also stated that *katame-waza* technical exercises should be practiced in different situations and conditions and athletes should master 5-7 of the *nage-waza* and *katame-waza* techniques in order to reach a high performance level (Santos et al., 2015).

Osaekomi-waza is an important part of judo training for both children and adults (Brasil et al., 2020; Ceylan & Balci, 2022; Fukuda et al., 2013). Many sports and studies in children involve intermittent high-intensity exercise activities based on running or cycling (Bauer et al 2022), whereas judo training involves repetition of judo-specific techniques or loads. In contrast to adult athletes, recommendations for high-intensity exercise and rest intervals in child athletes are limited due to the paucity of studies and methodological limitations (Eddolls et al., 2017). Nevertheless, high-intensity interval training has been demonstrated to be a time-efficient method to enhance performance and to allow time for the development of sport-specific skills. Consequently, it is recommended for incorporation into the training of young athletes (Engel et al., 2018). There is limited information related to the loads that athletes are exposed to as *tori* (who performed the technique) and *uke* (who received the technique) in judo trainings. Despite previous research examining the physiological load and/or performance outcomes of simulated judo matches where athletes are exposed to high level of perceptual load at the beginning of the combat or no change (Julio et al., 2018), and intermittent *osaekomi-waza* exercise in adult judo athletes (Ceylan & Balci, 2022) where athletes presented higher perceived exertion in *uke* role compared to *tori* role, there is no research on prepubescent child judo athletes. Furthermore, adult and child athletes may not respond in the same way to high-intensity exercises involving judo-specific technical skills because they have different levels of technical ability. Given that *osaekomi-waza* is an important part of judo training and contests, it is important to present physiological and perceptual loads athletes are exposed to in order to optimize the training. Therefore, this study aimed to compare the physiological and perceptual responses during intermittent *osaekomi-waza* exercise between *uke* and *tori* in prepubescent judo athletes. Our hypothesis in this study was that *uke* would present higher heart rate and higher rate of perceived exertion compared *tori*. In other words, the *uke* has to escape from the *osaekomi-waza* within 20 seconds in order not to lose the contest according to IJF competition rules (IJF, 2025), and the *uke* is exposed to more load due to the mass of the *tori* exerting pressure and thus would be exposed to more cardiovascular and perceptual load compared to *tori* who just spend effort to pin the *uke*.

2. Methods

2.1. Study design

This randomized cross-over study was divided into three sessions: anthropometric measurements and familiarization (session 1), and high-intensity interval *osaekomi-waza* exercise in both the *uke* (session 2) and *tori* (session 3). All measurements were carried out in a *dojo* which is a dedicated space for practicing judo. Following anthropometric measurements, an informative session was given to athletes about the measurements and procedures. Athletes received detailed instructions on the protocols, as well as information about physiological and perceptual measurements during the familiarization process. In the second and third sessions, following a standardized warm-up, athletes engaged in intermittent *osaekomi-waza* exercise with *kesa-gatame* acting as either *uke* or *tori*, with 4 sets × 20 seconds work and 10 seconds rest (1:½ work–rest ratio) (total exercise duration is 120 seconds) and they changed the roles in the preceding session in a randomized order. Athletes were matched according to weight category, and they completed the exercises with 24-hour intervals. Athletes were instructed to give the maximum effort during the *osaekomi-waza* exercise. When *uke* escaped from the pinning (known as *toketa*), the clock was paused, the athletes got back to their starting positions, and the time was resumed. HR was measured at rest, immediately after and 1 minute after each intermittent *osaekomi-waza* exercise, and during passive recovery while athletes were in sitting position. RPE was also assessed immediately following the workout.

2.2. Participants

The number of the participants was determined with a priori power analysis with GPower 3.1.9.7 (Universität Kiel, Kiel, Germany) (Faul et al., 2007). The assumptions used were $\alpha = 0.05$ and the power of 0.95 for one group with 2-way within-factor repeated measures ANOVA (3 measurement times × 2 roles). An actual power of 0.95 and a total sample size of 14 were determined. However, 15 judo athletes voluntarily participated in the study. The inclusion criteria were as follows: having at least 2 years of judo experience, participation in the tournaments or official judo

competitions during the last 6 months, no injury that prevents athletes from attending training, regular participation in training at least 4 days of the week, holding at least a green belt. The data related to participants' physical characteristics can be found in Table 1. The study was carried out according to the latest version of the Declaration of Helsinki and ethical approval was obtained from the local ethical committee (E-40990478-050.99-829869).

Table 1. Physical characteristics of the participants (*n*=15)

Variables	M±SD	95% CI
Age (year)	10.8±1.1	10.2-10.8
Height (cm)	135±1.0	130-140
Body mass (kg)	31.2±5.7	28.0-34.3
Body fat percentage (%)	17.3±6.8	13.6-21.1
Body mass index (kg/m^2)	16.9±2.3	15.6-18.2
Body muscle percentage (%)	32.9±2.4	31.6-34.2
Judo experience (year)	3.0±0.8	2.6-3.4

SD: Standard Deviation, CI: Confidence Interval for Mean Lower and Upper Bound

2.3. Measurements

Body composition: Athletes' body mass was assessed using a calibrated scale (TANITA BC-545, Japan) with 0.1 kg accuracy, and their height was measured using a portable stadiometer (Seca 222, USA) with 1 mm accuracy. The body mass index was calculated using the equation BMI = body mass (kg)/height (m^2). Body fat percentage (BFP) was measured using a skinfold caliper with a pressure of 10 g/sq mm at each angle. Muscle thickness was measured at two different sites: biceps and triceps. Body density was determined using Durnin and Womersley's equation, while body fat percentage was obtained using Siri's equation (Durnin & Womersley, 1974).

Heart rate and rating of perceived exertion: Resting heart rate (HR) was measured before each exercise after athletes rested in supine position for 30 minutes. Immediately and 1-min following the exercise HR was measured again. HR was monitored with an HR monitor (Seego, Realtrack Sytems, Spain). The maximum heart rate of the athletes was estimated by the Tanaka formula (Mahon et al., 2010). Athletes' rating of the perceived exertion (RPE) was determined using the facial RPE scale from 1 to 10 (van der Zwaard et al., 2023) immediately after the exercise. The athletes were asked "How was your workout?" and were instructed to give a global rating of perceived exertion for the entire session. The RPE scale allows athletes to present a subjective exertion rate for the exercise and is stated to be a valid marker of training intensity in athletes undertaking high-intensity interval exercise (Coutts et al., 2009).

2.4. Exercise Protocol

Intermittent osaekomi-waza exercise: Kesa-gatame was utilized to perform interval *osaekomi-waza* exercises. *Tori* attempted to pin the *uke* by controlling his head and arm for 20 seconds, while *uke* attempted to escape the pinning. Each exercise consisted of four sets of 20 seconds with 10-second breaks in between. Athletes in the same weight category were matched, and exercises were performed with 24-hour intervals. Athletes were instructed to exert maximal effort throughout the exercise, and when *uke* was able to escape from the pinning, the time was stopped, and athletes returned to their starting positions to finish 20 seconds.

2.5. Statistical Analysis

All statistical analyses were performed using JASP software (Version 0.16.0.4, Amsterdam, The Netherlands). The assumption of normality was assessed using the Shapiro–Wilk test and by examining skewness and kurtosis coefficients. Except for four variables (age, and RPEs following *uke* and *tori* roles during the intermittent *osaekomi-waza* exercise), all variables demonstrated normal distribution according to the Shapiro–Wilk test ($p > 0.05$). Additionally, the z-scores for skewness and kurtosis of the remaining three variables fell within the acceptable range of −1.96 to +1.96, confirming adequate normality (Mishra et al., 2019). Descriptive statistics were used to present

subjects' characteristics. Data were presented as mean and standard deviation with 95% confidence intervals (CI). A two-way (3×2) repeated measures ANOVA was used to determine changes in HR between measurement times and roles. Eta squared (η2) was calculated to determine the effect size (ES), using the 0.01, 0.06, and 0.14 considered as small, medium, and large effect sizes (Cohen, 1988). In case of a significant difference, a post-hoc test was applied with holm correction. RPE was compared using Wilcoxon signed-rank test between roles and a matched-rank biserial correlation was reported for effect size, and classified as 0.10 (small), 0.30 (medium), and 0.50 (large) (Cohen, 1992). Statistical significance was set at $p < 0.05$.

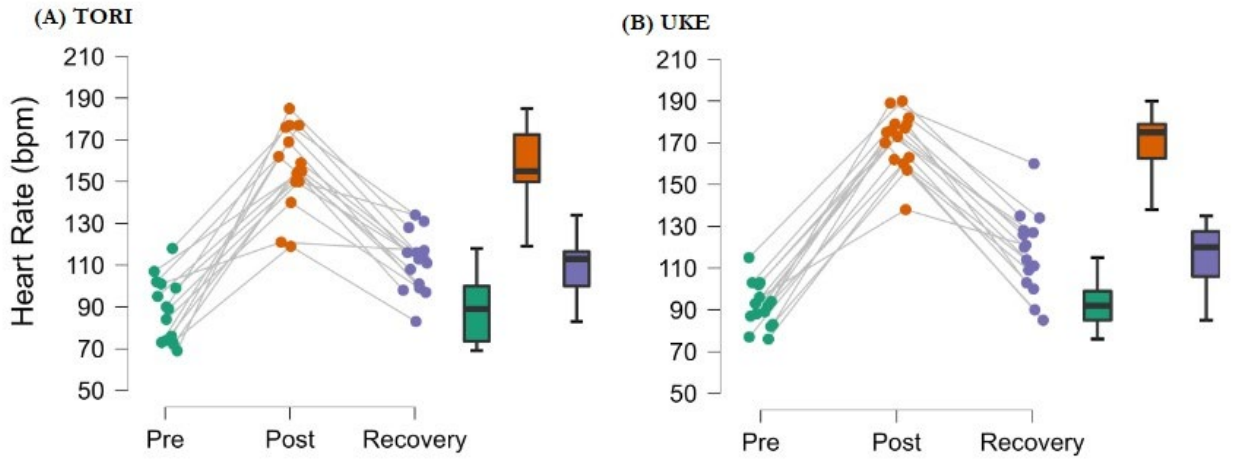
Considering the small sample size and the presence of small effect sizes, Bayesian statistical methods were employed in addition to classical frequentist approaches. Previous literature has highlighted that Bayesian analyses offer greater robustness and reliability in small-sample studies and allow results to be expressed directly in probabilistic terms, facilitating interpretation (Mengersen et al., 2016; Van de Schoot et al., 2021). Accordingly, a Bayesian repeated measures ANOVA test was conducted, and results were reported using Bayes factors (BF10) (Van den Bergh et al., 2023). Bayes factors quantify the relative evidence for the alternative hypothesis over the null hypothesis. A BF_{10} greater than 1 was interpreted as evidence favoring the alternative hypothesis, whereas a BF_{10} less than 1 indicated support for the null hypothesis (Van den Bergh et al., 2023).

3. Results

The results of the two-way repeated measures ANOVA showed a significant main effect of role on heart rate (HR) responses ($F(1,14)= 11.51$, $p= 0.01$, $\eta^2= 0.02$ [small]), indicating that the *uke* role was associated with higher HR values compared to the *tori* role at all measurement times. On average, 78% and 86% of maximum heart rate was achieved during the *tori* and *uke* roles, respectively.

A significant main effect of measurement time on HR was also observed based on the overall mean across roles ($F(2,28)= 208.86$, $p<0.001$, $\eta^2 = 0.87$ [large]), demonstrating that HR differed significantly between the pre-exercise, immediate post-exercise, and recovery periods. HR values were significantly higher immediately after *osaekomi-waza* exercise compared to the resting and 1-minute recovery periods ($p<0.001$). However, no significant interaction between role and measurement time was found ($F(2,28)= 0.54$, $p= 0.15$, $\eta^2= 0.01$ [small]), suggesting that the difference between roles remained consistent across time points.

Figure 1. Athletes' heart rate responses to intermittent *osaekomi-waza* exercise

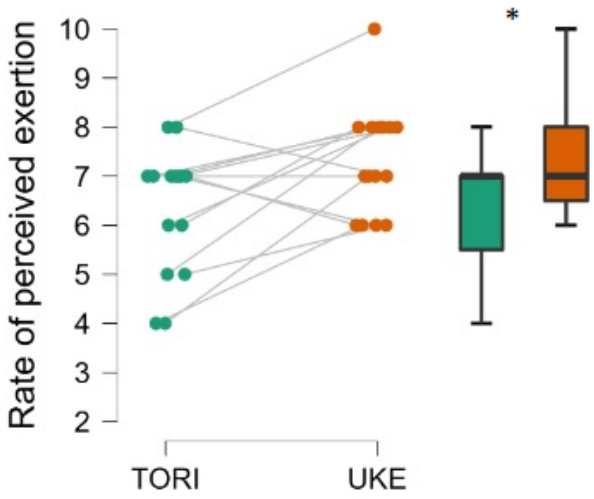


The results of the repeated measures Bayesian ANOVA were generally in line with the frequentist analysis, although the Bayesian model comparison showed that the data were equally likely under the null and alternative models ($BF_{10} = 1.00$), indicating equivocal evidence. HR responses varied with both roles (*uke* vs. *tori*) and measurement times (pre-exercise, immediate post-exercise, and recovery). The model that included the interaction between the role and the measurement time had a lower Bayes factor $BF_{10} = 0.87$), indicating that adding the interaction did

improve model fit. A Bayes factor close to 1 indicates equivocal evidence for the presence of an interaction effect. The model including only measurement time yielded a BF_{10} of 0.22, reflecting weak evidence, while the model including only role (BF_{10}= 1.37 × 10^{-15}) and the null model (BF_{10}= 3.24 × 10^{-16}) received no empirical support. Overall, these results corroborate the frequentist findings, suggesting that HR differences were predominantly due to the main effects of role and measurement time, with no significant interaction effect.

There was a significant difference in RPE responses between the *uke* and *tori* roles, with higher scores observed following the *uke* role compared to the *tori* role (Z= -2.34, p= 0.02, r= 0.74 [large]). The Bayesian model comparison corroborated this finding, providing moderate evidence for a difference (BF_{10}= 4.48).

Figure 2. Rate of perceived exertion (RPE) responses of *tori* and *uke* following the intermittent *osaekomi-waza* exercise, * indicates significant difference



4. Discussion

Understanding how different roles affect physiological and perceptual responses in prepubescent judo athletes is key to designing appropriate training protocols. The present study provides two important insights into the physiological and perceptual responses of prepubescent judo athletes. First, heart rate patterns did not differ between the *uke* and *tori* roles, indicating similar cardiovascular demands regardless of role. Second, RPE scores were elevated in the *uke* role, reflecting the greater perceived exertion associated with defensive actions in groundwork scenarios.

Despite the parallel trends observed in heart rate changes across roles, a persistent elevation in heart rate was documented in the *uke* role (main effect of role), albeit with a small effect size. Nevertheless, the Bayesian analysis indicated that the data provided equal support for both the presence and absence of a main effect. In adult athletes, Ceylan and Balci (2022) observed a clear elevation in heart rate following the *uke* role, although blood lactate levels remained similar between roles. It is well established that HR tends to return to resting levels quickly following maximal exercise, whereas blood lactate concentration typically continues to increase during the recovery period (Rimaud et al., 2010). When physiological outputs are evaluated in high-intensity exercise, the absence of any differentiation in blood lactate concentration, unlike heart rate, can be explained by this physiological mechanism. Building upon these findings, although studies such as Ceylan and Balci (2022) on senior judokas provide valuable context, future research is needed to explore whether physiological loads during *osaekomi-waza* are comparable across different age categories. Prepubescent children have distinctive physiological characteristics that diverge significantly from those observed in adults. They may exhibit a reduced work capacity, which is characterized by a perceived decline in efficiency when compared to adults (Ratel & Blazevich, 2017). The precise nature of the relationship between exercise and the influence of growth and maturation on determining cardiovascular responses in children remains to be fully elucidated. Disparities in stroke volume and maximum heart rate that are evident between children and adults have the capacity to influence cardiovascular responses to exercise. In addition, it is crucial to consider the influence of growth and maturation processes on these disparities (Schober, 1993). Therefore, future studies should specifically investigate age-related variations in response to *osaekomi-waza* exercises.

In line with the findings of Ceylan and Balcı (2022), the prepubescent athletes in the current study exhibited higher RPE responses in the *uke* role compared to the *tori* role. This difference may be attributed to the *uke*'s effort to escape from the pinning position, as well as the mechanical pressure exerted by the *tori*'s body mass. Similarly, Durmaz et al. (2023) investigated the acute cardiovascular and perceived exertion responses of child judo athletes performing the *tori* role during high-intensity intermittent uchi-komi and ne-waza exercises. Their results indicated lower

HR and RPE values following ne-waza exercises compared to uchi-komi exercises. These contrasting findings highlight that cardiovascular and perceptual responses can vary substantially depending on the exercise modality and the role performed.

Given the variability observed in children's responses across different exercise types and roles, it is also important to consider findings from adult populations to better contextualize these results. Studies conducted on adult judokas have demonstrated that ne-waza training induces lower heart rate, blood lactate concentration, and perceived exertion compared to tachi-waza and free randori (Houcine et al., 2024). Supporting these results, Ouergui et al. (2022) reported lower post-exercise lactate levels and peak heart rates during ne-waza sessions compared to standing practice.

Building on this, it is essential to understand how physiological and perceptual outcomes vary based on athletes' physiological capacities and competitive levels (Kons & Detanico, 2022). Thus, technique selection and competitive level should be carefully considered when designing training protocols aimed at optimizing physiological and perceptual adaptations. Moreover, although physiological and perceptual responses appear similar when applying uchi-komi exercises with techniques of different characteristics, variations in rest periods have been shown to significantly affect these responses (Franchini, Panissa, & Julio, 2013)). Future research should explore these training variables in greater depth to develop more effective and individualized strategies for nage-waza and ne-waza exercises, particularly for prepubescent judo athletes.

Nevertheless, some limitations should be considered. One important point is the potential impact of maturity status (i.e., deviation from peak height velocity) on performance in exercise tests, as highlighted in previous studies (Jones et al., 2000). Although the participants in the present study had not yet reached peak height velocity (data not shown), it is hypothesized that variations in maturation stage could influence physiological responses to high-intensity intermittent *osaekomi-waza* exercise. Therefore, it is advised that future studies incorporate assessments of biological maturation to better understand the potential impact of maturity status on judo training responses in young athletes. Although the number of athletes was verified by a priori power analysis, it is recommended to include a larger number of athletes from different competitive levels and age categories to obtain more reliable and diverse results. HR following each work period could be followed as well as mean and maximum HR during the whole session, which is suggested for future studies to monitor load during the whole session. To support this hypothesis, it is suggested that future research should use measures such as blood lactate concentration, oxygen consumption, etc. to measure exercise stress.

5. Conclusions and practical applications

In conclusion, although heart rate patterns were similar between the *uke* and *tori* roles during intermittent *osaekomi-waza* exercise, higher RPE responses were observed following the *uke* role. This suggests that the *uke* role places greater perceptual demands on prepubescent judo athletes. Therefore, coaches should be aware that the *uke* role may be more challenging for young athletes, despite similar physiological patterns across roles. Furthermore, implementing tailored training strategies that account for the increased perceptual load associated with the *uke* role may promote better adaptation and reduce the risk of early fatigue in prepubescent judo athletes. In addition, coaches may consider alternating roles more frequently or adjusting the duration of the *uke* role to evenly distribute the training load, increase engagement, and minimize premature fatigue in prepubescent judo athletes.

References

Adam, M., Klimowicz, P., & Pujszo, R. (2016). Judoists' tactical and technical efficiency during the World Championships in 2014 and 2015. *Baltic Journal of Health and Physical Activity*, *8*(2), 19-28. https://doi.org/10.29359/BJHPA.08.2.02

Agostinho, M. F., & Franchini, E. (2021). Observational analysis of the variability of actions in judo: the key for success? *Revista de Artes Marciales Asiáticas*, *15*(2), 69-77. https://doi.org/10.18002/rama.v15i2.6341

Barreto, L. B. M., Aedo-Muñoz, E. A., Soto, D. A. S., Miarka, B., & Brito, C. J. (2022). Has there been a change between combat time in male judo? Analysis of the top 20 athletes by weight division

between the 2016-20 Olympic cycles. *International Journal of Performance Analysis in Sport*, *22*(4), 541-557. https://doi.org/10.1080/24748668.2022.2086516

Barreto, L. B. M., Miarka, B., dos Santos Silva, R. J., Bragazzi, N. L., Slimani, M., Znazen, H., Soto, D. A. S., Aedo-Muñoz, E. A., & Brito, C. J. (2022). The effects of weight categories on the time-motion analysis of female high-level judo athletes between the 2016 and 2020 Olympic cycles. *Frontiers in Psychology*, *13*, 1012517. https://doi.org/10.3389/fpsyg.2022.1012517

Boguszewski, D. (2016). Analysis of the final fights of the judo tournament at Rio 2016 Olympic Games. *Journal of Combat Sports and Martial Arts*, *7*(2), 63-68.

Brasil, I., Monteiro, W., Lima, T., Seabra, A., & Farinatti, P. (2020). Effects of judo training upon body composition, autonomic function, and cardiorespiratory fitness in overweight or obese children aged 8- to 13 years. *Journal of Sports Sciences*, *38*(21), 2508-2516. https://doi.org/10.1080/02640414.2020.1792189

Ceylan, B., & Balci, S. S. (2018). The comparison of judo-specific tests. *Ido Movement for Culture. Journal of Martial Arts Anthropology, 18*(4), 54-62. https://doi.org/10.14589/ido.18.4.7

Ceylan, B., & Balci, Ş. S. (2022). Comparison of physiological and perceptual load between uke and tori after intermittent osaekomi-waza exercise in judo. *International Journal of Performance Analysis in Sport*, *22*(4), 505-515. https://doi.org/10.1080/24748668.2022.2084593

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd Edition)*. Routledge.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155-159. https://doi.org/10.1037//0033-2909.112.1.155

Coutts, A. J., Rampinini, E., Marcora, S. M., Castagna, C., & Impellizzeri, F. M. (2009). Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *Journal of Science and Medicine in Sport*, *12*(1), 79-84. https://doi.org/10.1016/j.jsams.2007.08.005

Da Silva, L. S., Neto, N. R. T., Lopes-Silva, J. P., Leandro, C. G., & Silva-Cavalcante, M. D. (2021). Training protocols and specific performance in judo athletes: A systematic review. *Journal of Strength and Conditioning Research*. https://doi.org/10.1519/jsc.0000000000004015

Durmaz, M., Taşkın, H. B., & Ceylan, B. (2023, 08-10 May 2023). Acute Physiological and Perceptual Responses of Child Judo Athletes to High-Intensity Interval Uchi-Komi and Ne-Waza Exercises. 1*5th National Sport Sciences Student Congress*, Ankara, Türkiye.

Durnin, J. V., & Womersley, J. (1974). Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *The British journal of nutrition*, *32*(1), 77-97. https://doi.org/10.1079/bjn19740060

Eddolls, W. T. B., McNarry, M. A., Stratton, G., Winn, C. O. N., & Mackintosh, K. A. (2017). High-Intensity Interval Training Interventions in Children and Adolescents: A Systematic Review. *Sports Medicine*, *47*(11), 2363-2374. https://doi.org/10.1007/s40279-017-0753-8

Engel, F. A., Ackermann, A., Chtourou, H., & Sperlich, B. (2018). High-intensity interval training performed by young athletes: A systematic review and meta-analysis. *Frontiers in physiology*, *9*, 1012. https://doi.org/10.3389/fphys.2018.01012

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. https://doi.org/10.3758/BF03193146

Franchini, E., Artioli, G. G., & Brito, C. J. (2013). Judo combat: time-motion analysis and physiology. *International Journal of Performance Analysis in Sport*, *13*(3), 624-641. https://doi.org/10.1080/24748668.2013.11868676

Franchini, E., Panissa, V. L. G., & Julio, U. F. (2013). Physiological and performance responses to intermittent uchi-komi in judo. *Journal of Strength and Conditioning Research*, *27*(4). https://doi.org/10.1519/JSC.0b013e3182606d27

Franchini, E., Takito, M. Y., & Calmet, M. (2013). European Judo Championships: impact of the new rule changes on points and penalties. *International Journal of Performance Analysis in Sport*, *13*(2), 474-479. https://doi.org/10.1080/24748668.2013.11868663

Fukuda, D. H., Stout, J. R., Kendall, K. L., Smith, A. E., Wray, M. E., & Hetrick, R. P. (2013). The Effects of Tournament Preparation on Anthropometric and Sport-Specific Performance Measures in Youth Judo Athletes. *The Journal of Strength & Conditioning Research*, *27*(2), 331-339. https://doi.org/10.1519/JSC.0b013e31825423b3

Houcine, N., Ouergui, I., Bouassida, A., Franchini, E., & Bouhlel, E. (2024). The effects of training type and area size variations on the physiological and session rating of perceived exertion

responses during male judo matches. *Biology of Sport*, *41*(1), 53-59. https://doi.org/10.5114/biolsport.2024.127381

IJF. (2025). *Sport and Organisation Rules*. Retrieved 29 January from https://www.ijf.org/ijf/documents/6

Jones, M. A., Hitchen, P. J., & Stratton, G. (2000). The importance of considering biological maturity when assessing physical fitness measures in girls and boys aged 10 to 16 years. *Annals of Human Biology*, *27*(1), 57-65. https://doi.org/10.1080/030144600282389

Julio, U. F., Gonçalves Panissa, V. L., Agostinho, M. F., Cury, R. L., Esteves, J. V., & Franchini, E. (2018). Time-course of time-motion, physiological, perceived exertion and neuromuscular responses during simulated judo matches. *International Journal of Performance Analysis in Sport*, *18*(4), 582-594. https://doi.org/10.1080/24748668.2018.1507479

Kons, R. L., Agostinho, M. F., Santos, D. F. C., Lopes-Silva, J., Detanico, D., & Franchini, E. (2022). Match-related performance during the Olympic Games 2020: a technical variability analysis of high-level judo athletes. *International Journal of Performance Analysis in Sport*, *22*(4), 516-525. https://doi.org/10.1080/24748668.2022.2084594

Kons, R. L., & Detanico, D. (2022). High-Intensity Interval Exercise Performance in Judo Athletes: Physiological, Perceptual, and Pacing Responses. *Motor Control*, *26*(3), 353-361. https://doi.org/10.1123/mc.2022-0002

Kons, R. L., Saldanha Da Silva Athayde, M., Ceylan, B., Franchini, E., & Detanico, D. (2021). Analysis of video review during official judo matches: effects on referee's decision and match results. *International Journal of Performance Analysis in Sport*, *21*(4), 555-563. https://doi.org/10.1080/24748668.2021.1926165

Mahon, A. D., Marjerrison, A. D., Lee, J. D., Woodruff, M. E., & Hanna, L. E. (2010). Evaluating the Prediction of Maximal Heart Rate in Children and Adolescents. *Research Quarterly for Exercise and Sport*, *81*(4), 466-471. https://doi.org/10.1080/02701367.2010.10599707

Marcon, G., Franchini, E., Jardim, J. R., & Neto, T. L. B. (2010). Structural analysis of action and time in sports: Judo. *Journal of Quantitative Analysis in Sports*, *6*(4). https://doi.org/doi:10.2202/1559-0410.1226

Mengersen, K. L., Drovandi, C. C., Robert, C. P., Pyne, D. B., & Gore, C. J. (2016). Bayesian estimation of small effects in exercise and sports science. *PLoS One*, *11*(4), e0147311. https://doi.org/10.1371/journal.pone.0147311

Miarka, B., Cury, R., Julianetti, R., Battazza, R., Julio, U. F., Calmet, M., & Franchini, E. (2014). A comparison of time-motion and technical–tactical variables between age groups of female judo matches. *Journal of Sports Sciences*, *32*(16), 1529-1538. https://doi.org/10.1080/02640414.2014.903335

Miarka, B., Panissa, V. L. G., Julio, U. F., Del Vecchio, F. B., Calmet, M., & Franchini, E. (2012). A comparison of time-motion performance between age groups in judo matches. *Journal of Sports Sciences*, *30*(9), 899-905. https://doi.org/10.1080/02640414.2012.679675

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia*, *22*(1), 67. https://doi.org/10.4103/aca.ACA_157_18

Ouergui, I., Delleli, S., Chtourou, H., Formenti, D., Bouhlel, E., Ardigò, L. P., & Franchini, E. (2022). The role of competition area and training type on physiological responses and perceived exertion in female judo athletes. *International Journal of Environmental Research and Public Health*, *19*(6), 3457. https://doi.org/10.3390/ijerph19063457

Ratel, S., & Blazevich, A. J. (2017). Are Prepubertal Children Metabolically Comparable to Well-Trained Adult Endurance Athletes? *Sports Medicine*, *47*(8), 1477-1485. https://doi.org/10.1007/s40279-016-0671-1

Rimaud, D., Messonnier, L., Castells, J., Devillard, X., & Calmels, P. (2010). Effects of compression stockings during exercise and recovery on blood lactate kinetics. *European Journal of Applied Physiology*, *110*(2), 425-433. https://doi.org/10.1007/s00421-010-1503-x

Santos, L., Fernández-Río, J., Almansba, R., Sterkowicz, S., & Callan, M. (2015). Perceptions of top-level judo coaches on training and performance. *International Journal of Sports Science & Coaching*, *10*(1), 145-158. https://doi.org/10.1260/1747-9541.10.1.145

Schober, P. (1993). Sport und Training im Kindesalter-Allgemeine Grundlagen. *Padiatrie und padologie*, *28*, A 53-A 53.

Van de Schoot, R., Depaoli, S., King, R., Kramer, B., Märtens, K., Tadesse, M. G., Vannucci, M., Gelman, A., Veen, D., & Willemsen, J. (2021). Bayesian statistics and modelling. *Nature Reviews Methods Primers*, *1*(1), 1. https://doi.org/10.1038/s43586-020-00001-2

Van den Bergh, D., Wagenmakers, E.-J., & Aust, F. (2023). Bayesian repeated-measures analysis of variance: An updated methodology implemented in JASP. *Advances in Methods and Practices in Psychological Science*, *6*(2). https://doi.org/10.1177/25152459231168024

van der Zwaard, S., Hooft Graafland, F., van Middelkoop, C., & Lintmeijer, L. L. (2023). Validity and Reliability of Facial Rating of Perceived Exertion Scales for Training Load Monitoring. *The Journal of Strength & Conditioning Research*, *37*(5), e317-e324. https://doi.org/10.1519/jsc.0000000000004361

Weldon, A., Cloak, R., Kirk, C., Ruddock, A., Langan-Evans, C., Detanico, D., Loturco, I., & Kons, R. (2024). Strength and Conditioning (S&C) Practices of Judo Athletes and S&C Coaches: A Survey-Based Investigation. *The Journal of Strength & Conditioning Research*, *38*(4), e160-e173. https://doi.org/10.1519/jsc.0000000000004673

Witkowski, K., Maśliński, J., & Kotwica, T. (2012). Analysis of fighting actions of judo competitors on the basis of the men's tournament during the 2008 Olympic Games in Beijing. *Journal of Combat Sports and Martial Arts*, *3*(2), 121-129.

Zhang, Z., Xie, L., Ji, H., Chen, L., Gao, C., He, J., Lu, M., Yang, Q., Sun, J., & Li, D. (2024). Effects of different work-to-rest ratios of high-intensity interval training on physical performance and physiological responses in male college judo athletes. *Journal of Exercise Science & Fitness*, *22*(3), 245-253. https://doi.org/10.1016/j.jesf.2024.03.009

~

Authors' biographical data

Bayram Ceylan (Türkiye) is an Associate Professor at the Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University. He is serving as a member of the Educational Committee of the Turkish Judo Federation and the Scientific Committee of the European Judo Union. He has IJF Level 1 coaching certificate and 3rd level of coaching certificate issued by Turkish Judo Federation. He has twenty years of experience in judo and represented his country at the international level with European medal and has prestigious publications on judo-specific tests, different exercise modalities in judo, dehydration in judo, and judo match analysis. E-mail: bceylan@kastamonu.edu.tr

Furkan Öztürk (Türkiye) is a research assistant at Düzce University, Department of Coaching Education. He successfully completed his master's thesis titled "The Effect of Different Times of the Day on Judo Performance" at Selçuk University, Department of Coaching Education. He continues his PhD education at Selçuk University Institute of Health Sciences, Department of Coaching Education. He is working on physiology related studies such as judo-specific performance, athletic performance, circadian rhythm. He has 14 years of judo experience and has participated in national team level competitions. He has a 3rd Dan black belt and also has a 3rd Level Senior Coach Certificate. He is also an athletic performance coach in a professional basketball club. E-mail: fozturk@duzce.edu.tr

Hasan Basri Taşkın (Türkiye) is a research assistant at the Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University and master's student at Department of Coaching Education, Institute of Health Sciences, Kastamonu University. He is a volunteer coach working with kids aged 9-14. He has 9 years of judo experience and has participated in national and international competitions. He has publications about judo at prestigious journals. E-mail: hbtaskin@kastamonu.edu.tr

Uğur Sarıkaya (Türkiye) is a research assistant at Harran University. He continues his master's degree in Physical Education and Sports. His research areas are athlete health and training sciences. He has 15 years of judo experience and has a 3rd Dan Black belt. He is a member of Educational and Scientific Commissions of Turkish Judo Federation and has 3rd Level Senior Coach Sertificate. In his elite athlete career, he achieved the 3rd place in the World in cadets. E-mail: ugursarikaya1923@gmail.com

Şükrü Serdar Balcı (Türkiye) currently works as a full professor at Coaching Education, Faculty of Sport Sciences, Selçuk University. He was interested in judo. He does research about exercise performance, match analysis, weight loss in judo. E-mail: ssbalci@gmail.com; ssbalci@selcuk.edu.tr