The effect of combined skipping and smash drill training on smash accuracy of PB Garuda badminton players

El efecto del entrenamiento combinado de saltos y remates en la precisión de remates de los jugadores de bádminton de PB Garuda

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Abstract

Introduction: A range of training methodologies has been explored to enhance smash accuracy, encompassing both technical drills and physical conditioning exercises. However, an exclusive focus on either technical or physical elements often neglects the holistic demands required for executing a successful smash. The integration of a combined skipping and smash drill training approach presents a promising solution, melding physical conditioning with technical skill enhancement.
Objective: This study endeavors to evaluate the effectiveness of combined skipping and smash drill training in enhancing smash accuracy among professional badminton athletes.
Methodology: The research employed an experimental method with a "pretest-posttest control group design." The sample consisted of 20 participants, divided into two groups: an experimental group and a control group. Smash accuracy was measured using the James Poole accuracy test instrument. Descriptive analysis was performed to determine the mean values of all data. Statistical analysis was conducted using the paired sample t test significance level 5%.
Results: The training group showed improved in the smash accuracy between baseline (pre) and week 6 (post) (mean±SD: 14.20±1.99 vs 24.70±3.49; Effect size (ES) = 3.691; p = 0.05).
Conclusions: This study found that the combination of skipping and smash drill training significantly increased smash accuracy in PB Garuda badminton players.

Keywords

Badminton players; smash accuracy; skipping training; smash drill training.

Resumen

Introducción: Se ha explorado una variedad de metodologías de entrenamiento para mejorar la precisión del smash, que abarca tanto ejercicios técnicos como ejercicios de acondicionamiento físico. Sin embargo, centrarse exclusivamente en los elementos técnicos o físicos a menudo descuida las demandas holísticas necesarias para ejecutar un smash exitoso. La integración de un enfoque de entrenamiento combinado de saltos y ejercicios de smash presenta una solución prometedora, que combina el acondicionamiento físico con la mejora de las habilidades técnicas.
Objetivo: Este estudio intenta evaluar la efectividad del entrenamiento combinado de salto y smash para mejorar la precisión del smash entre atletas profesionales de bádminton.
Metodología: La investigación empleó un método experimental con un "diseño de grupo de control pretest-postest". La muestra estuvo compuesta por 20 participantes, divididos en dos grupos: un grupo experimental y un grupo control. La precisión del aplastamiento se midió utilizando el instrumento de prueba de precisión de James Poole. Se realizó un análisis descriptivo para determinar los valores medios de todos los datos. El análisis estadístico se realizó utilizando la prueba t para muestras pareadas nivel de significancia 5%.
Resultados: El grupo de entrenamiento mostró una mejora en la precisión del smash entre el inicio (antes) y la semana 6 (después) (media ± DE: 14,20 ± 1,99 frente a 24,70 ± 3,49; Tamaño del efecto (ES) = 3,691; p = 0,05).
Conclusiones: Este estudio encontró que la combinación de entrenamiento de saltos y ejercicios de smash aumentó significativamente la precisión del smash en jugadores de bádminton de PB Garuda.

Palabras clave

Jugadores de bádminton; aplastar precisión; saltarse el entrenamiento; entrenamiento de taladro aplastante.

Introduction

Badminton is one of the most widely played racket sports globally, requiring a combination of speed, agility, and strategic precision (Walankar & Josheeta, 2023). It is recognized as one of the most popular sports worldwide, particularly in Asia, where it is among the top-ranked sports in terms of participation (Badminton World Federation (BWF), 2024). Among the many techniques in badminton, the smash stands out as a game-changing offensive maneuver, capable of shifting match momentum instantly (Miller et al., 2016). A well-executed smash relies on explosive power, precise timing, and accuracy, ensuring that the shuttlecock is placed in areas that challenge the opponent's ability to return (Asif et al., 2018). Accuracy, in particular, plays a crucial role, in determining whether a smash becomes a winning shot or merely an easy return for the opponent (Kahar et al., 2021). However, despite its importance, even professional players often struggle with consistent smash accuracy, which can significantly impact their overall performance (Le Mansec et al., 2020; Li et al., 2017; Afzal et al., 2020).

The rapid growth of badminton, especially in Indonesia, has led to an increasing number of clubs and training programs designed to develop high-performing athletes (Kurniadi et al., 2021). However, in a sport where milliseconds and millimeters can decide a match, precision and consistency in executing smashes remain key challenges (Rustandi & Safitri, 2019). A misplaced smash not only reduces its offensive impact but can also create opportunities for opponents to counterattack (Kobayashi et al., 2023). Without effective, structured training methods, athletes may struggle to compete at the highest levels, where every point demands technical excellence (Lin et al., 2022). Beyond performance, inconsistent smash accuracy can also affect an athlete's confidence, influencing their overall gameplay and decision-making (Ma et al., 2024).

Consequently, there is a pressing need for research into innovative and effective training strategies aimed at improving smash accuracy, enabling athletes to maintain competitiveness in an increasingly rigorous environment (Kuswanti et al., 2024). Various training methodologies have been explored to enhance smash accuracy, ranging from technical drills emphasizing shot precision to physical conditioning exercises designed to improve power and endurance (Darsono et al., 2023; Endrawan et al., 2024; Denatara, 2024). However, many of these methods are applied in isolation, focusing solely on either the technical or physical aspects, which may limit their overall effectiveness in replicating the complex demands of in-game scenarios (Kumar & Das, 2024). Studies have shown that a lack of integration between technical skill training and physical conditioning can result in reduced performance transfer, where improvements seen in controlled drills do not always translate into match situations (Harrison et al., 2021; Feng et al., 2022). Given these challenges, there is growing interest in hybrid training approaches that simultaneously enhance technical precision and physical attributes to optimize on-court performance (Gabbett, 2008; Wicaksono et al., 2022). One such approach is the integration of skipping and smash drill training, which offers a comprehensive method that enhances neuromuscular coordination, lower-body explosiveness, and biomechanical efficiency, all of which are essential for executing an accurate and powerful smash (Lin et al., 2023; Roelker et al., 2022).

Is well-known that skipping develops cardiovascular endurance, lower-body strength, and neuromuscular coordination (Lin et al., 2023). The repetitive nature of skipping drills effectively engages major muscle groups, including the gastrocnemius, quadriceps, and hamstrings, fostering improved stability, proprioception, and explosive power necessary for executing jump smashes (Anugrah et al., 2023; Chen & Wu, 2022; Danubisma & Dewi, 2023; Roelker et al., 2022). Concurrently, smash drills concentrate on biomechanical efficiency, particularly the kinetic chain, optimizing the transfer of momentum from the lower body through to the upper body and ultimately into the racket during the smash execution (Edmizal et al., 2024; Kumar et al., 2024).

This study aims to investigate the effectiveness of combined skipping and smash drill training in improving smash accuracy among professional badminton athletes. Beyond assessing its impact, the study also seeks to provide empirical support for this training method, offering practical insights for coaches and athletes in designing structured training regimens. Ultimately, these findings are expected to contribute to the continuous advancement of badminton training methodologies, ensuring athletes are better equipped to perform at the highest levels.

Method

This study employed a quasi experimental approach within a positivist framework, utilizing a Pretest-Posttest Control Group Design to assess the effectiveness of skipping and smash drill training on smash accuracy. Participants were randomly assigned to either an experimental group, which received the targeted training intervention, or a control group, which followed their regular training regimen. Both groups underwent pretests to establish baseline performance and posttests after the intervention period to measure improvements.

The study population consisted of badminton players from PB Garuda, with participants selected through purposive sampling based on the following inclusion criteria: (1) male doubles players aged 17–20 years, (2) at least two years of structured training experience, and (3) willingness to participate. A total of 20 participants were assigned to two groups (10 per group) using ordinal pairing to ensure balanced skill levels.

Sample size determination was conducted using G*Power 3.1 (Faul et al., 2007), setting $\alpha = 0.05$, power $(1-\beta) = 0.80$, and effect size $(d) = 0.8$. The effect size was based on previous studies that examined the impact of plyometric-based interventions on badminton-specific skills, where moderate to large effects ($d = 0.6 – 0.9$) were observed for training programs targeting explosive power and accuracy (Chen, 2023; Li et al., 2017; Deng et al., 2021). Additionally, given that the study employed a repeated measures design (pretest-posttest), an additional power analysis was conducted to account for within-subject correlations ($r = 0.5$). The analysis confirmed that a minimum of 10 participants per group was sufficient to detect statistically meaningful differences, achieving a post-hoc power of 0.82, ensuring the study's sensitivity in detecting training effects.

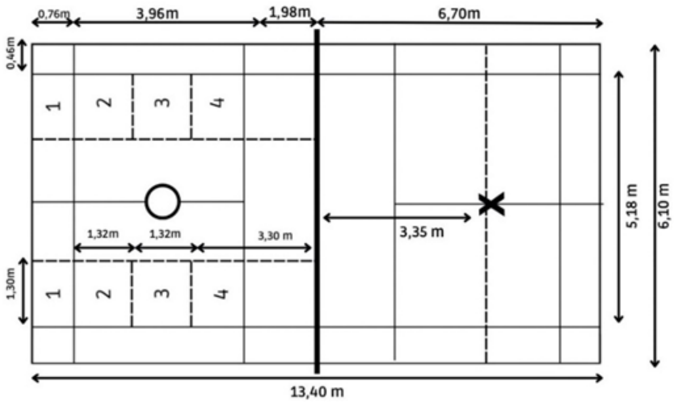
This study adhered to ethical research principles by ensuring that all participants were fully informed about the study objectives, procedures, and potential risks before their involvement. Verbal informed consent was obtained from all participants, affirming their voluntary participation. They were also informed of their right to withdraw at any time without negative consequences. To maintain confidentiality, all collected data were anonymized and used solely for research purposes.

The research was conducted at GOR Bulutangkis Wates Paciran Lamongan from April to June 2024, comprising 18 training sessions over six weeks. The six-week duration was chosen based on previous studies indicating that neuromuscular adaptations to sport-specific plyometric training typically emerge within 4–6 weeks (Mirzaei et al., 2013). Furthermore, interventions specifically designed for badminton with a duration of 3 - 12 weeks have been shown to significantly improve accuracy, agility, and explosive power (Deng et al., 2024). Each 90-minute training session was structured into four main components: warm-up, skipping drills, smash drills, and cool-down. The 15-minute warm-up phase included light jogging (5 minutes), dynamic stretching (5 minutes), and shadow badminton exercises (5 minutes) to prepare athletes for high-intensity movements. Following this, 20-minute skipping drills were performed, progressing across three phases: in weeks 1–2, athletes executed basic two-foot jumps (100 repetitions per set, 3 sets). In weeks 3–4, the drills advanced to alternating foot jumps and lateral skips (120 repetitions per set, 3 sets). Finally, in weeks 5–6, the intensity increased with double-unders and speed skipping (150 repetitions per set, 3 sets). Skipping drills were incorporated as they are known to enhance lower-body strength, neuromuscular coordination, and agility, all of which are critical for executing a powerful and accurate smash (Anugrah et al., 2023; Roelker et al., 2022). The 40-minute smash drill segment followed a progressive structure based on shot complexity. During weeks 1–2, players engaged in static shuttle placement drills to refine their accuracy. In weeks 3–4, the training intensity increased with semi-dynamic smashes, designed to improve precision under movement conditions. Finally, in weeks 5–6, athletes performed full-court smash drills, simulating real-game conditions to optimize accuracy under match pressure. To facilitate optimal recovery and prevent overtraining, training sessions were held three times per week, with a minimum of 48 hours of rest between sessions (Doherty et al., 2021). Additionally, intensity progression was carefully managed using a linear periodization approach, gradually increasing training volume and complexity each week. Athlete fatigue and workload adaptation were monitored using the Rate of Perceived Exertion (RPE) scale, ensuring a balance between progressive overload and recovery (Haddad, 2017). The 15-minute cool-down phase at the end of each session included static stretching, aimed at promoting muscle recovery and flexibility, thereby reducing the risk of injuries.

While the experimental group followed this structured skipping and smash drill training program, the control group maintained their regular training regimen without additional skipping drills or targeted smash training. Their sessions included technical drills such as net play, drop shots, and clear shots, along with general physical conditioning focused on endurance and strength without specific emphasis on explosive power or smash accuracy. Additionally, the control group engaged in match simulations to maintain tactical awareness and gameplay strategy. This study design ensured that any observed improvements in the experimental group could be attributed to the intervention rather than general training effects.

Smash accuracy was measured using the James Poole Accuracy Test (Poole, 2016), a widely recognized assessment tool in badminton research. The test has demonstrated high inter-rater reliability (ICC = 0.89) and strong construct validity for evaluating smash precision in controlled environments (Hung et al., 2020; Darsono et al., 2023). Participants completed 10 smash attempts per session, using 10 shuttlecocks, with scoring categorized as follows: 31–40 points (good accuracy), 21–30 points (moderate accuracy), and ≤20 points (poor accuracy).

Figure 1. Accuracy test for smash Source: (Poole, 2016).



Data analysis was performed using SPSS 29, beginning with Kolmogorov-Smirnov and Levene's tests to assess normality and homogeneity of variance. To evaluate training effectiveness, paired t-tests compared pretest and posttest scores within each group, while independent t-tests examined differences between the experimental and control groups. The magnitude of the observed effects was measured using Cohen's d. Additionally, a post-hoc power analysis using G*Power (Faul et al., 2007) confirmed that, with $\alpha = 0.05$, power $(1-\beta) = 0.80$, and effect size (d) = 0.8, the study achieved a statistical power of 0.82, indicating that the sample size was sufficient to detect significant differences between groups.

Results

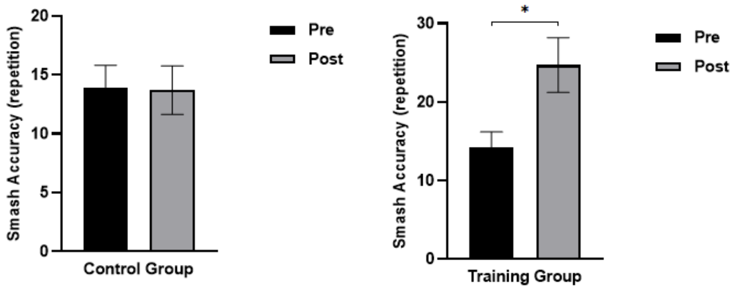
The results of the analysis of participant baseline characteristics are presented in Table 1. In Table 1, no significant differences were observed in age, resting heart rate, oxygen saturation, blood pressure, weight, height, body mass index, percentage of body fat, and muscle mass ($p > 0.05$). Assessment of smash accuracy at baseline (pre) and week 6 (post) in each group are presented in in Figure 2.

Table 1. Participants Baseline Characteristic.

Parameters	Control (n=10)	Training (n=10)	p-value Independent sample t-test
Age, yrs	19.20±0.92	19.60±0.97	0.355
Resting heart rate, bpm	69.30±7.01	71.20±3.74	0.459
Oxygen saturation, %	97.70±1.16	97.60±1.43	0.866
Systolic blood pressure, mmHg	116.50±3.84	117.70±2.54	0.422
Diastolic blood pressure, mmHg	74.80±6.05	74.60±3.59	0.929
Weight, kg	59.30±3.27	61.60±4.52	0.209
Height, m	1.68±0.04	1.69±0.03	0.274
Body mass index, kg/m^2	21.05±0.72	21.38±1.08	0.442

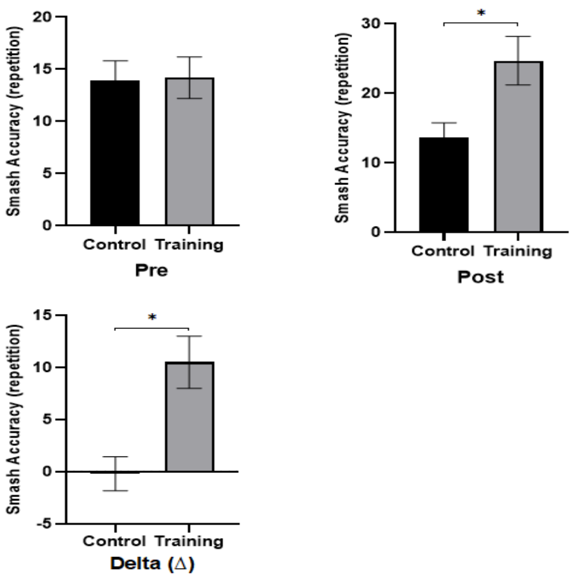
Percentage of body fat, %	16.68±2.81	16.72±2.73	0.975
Muscle mass, kg	48.39±5.89	48.91±6.97	0.861

Figure 2. Assessment of baseline (pre) and week 6 (post) smash accuracy in each group. (*) Significant at pre in training group (p < 0.05).



There was no significant difference in smash accuracy between baseline (pre) and week 6 (post) in the control group (95% Confidence Interval (95% CI): -0.96 to 1.36; p=0.705; ES: 0.101), whereas in the training group there was a significant difference observed (95% CI: -12.29 to -8.71; p=0.001; ES: 3.691). Assessment of smash accuracy at baseline (pre) and week 6 (post) between group are presented in in Figure 3.

Figure 3. Smash accuracy assessment at baseline (pre) and week 6 (post) between group. (*) Significant at control group (p < 0.05).



In smash accuracy, we detected a non-significant difference from the baseline (pre) of the training group versus the control group (mean±SD: 14.20±1.99 vs. 13.90±1.91; 95% Confidence Interval (95% CI): -2.13 to 1.53; p = 0.735; ES = 0.153). However, a significant increase in smash accuracy was seen at week 6 (post) when compared with baseline (pre) in the training group versus the control group (mean±SD: 24.70±3.49 vs. 13.70±2.06; 95% CI: -13.69 to -8.31; p = 0.05; ES = 3.833). Delta increase in smash accuracy was also seen in the training group versus the control group (mean±SD: 10.50±2.51 vs. -0.20±1.62; 95% CI: -12.68 to -8.72; p = 0.001; ES = 5.072).

Discussion

The results of this study demonstrate that the combination of skipping and smash drill training significantly improves smash accuracy among PB Garuda badminton players. The experimental group recorded substantially higher post-test scores compared to the control group, suggesting that an integrated training approach that targets both physical conditioning and technical skill development is more effective than traditional methods that focus solely on one aspect. These findings emphasize the necessity of holistic training methods that align with the complex physical and technical demands of badminton, where success depends not only on explosive power but also on precision and shot consistency.

A deeper examination of why this intervention was effective highlights several key physiological and biomechanical adaptations that likely contributed to the improvements in smash accuracy. One possible explanation is that skipping drills enhanced lower-body strength, neuromuscular coordination, and agility, all of which are critical for executing a powerful and well-placed smash (Trecroci et al., 2015; Li & Li, 2024). Research suggests that plyometric-based exercises, such as skipping, improve reactive strength and movement efficiency, which in turn enhances the ability to generate force during a jump smash (Lin et al., 2023; Gulati, 2024). Additionally, the rhythmic nature of skipping may have improved timing and coordination, reducing movement inefficiencies during the shuttlecock approach (McCrary & Gould, 2023). From a technical standpoint, smash drills contributed to improved kinetic chain efficiency, ensuring that energy generated from the lower body was effectively transferred through the upper body and into the racket (Kumar & Das, 2024). Over time, the repetitive practice of smash techniques likely helped refine racket control, shuttlecock placement, and shot accuracy, demonstrating how a combined physical and technical approach can lead to meaningful performance gains.

These findings align with previous research emphasizing the synergistic benefits of integrated training approaches. Chen (2023) demonstrated that functional training enhances hitting quality by improving baseline accuracy and depth, while also strengthening muscles and increasing flexibility in key areas such as the shoulders, hips, and knees. Similarly, Li et al. (2017) highlighted the role of body positioning in influencing shuttlecock release angles and clearance heights, indicating that repetitive technical training, such as smash drills, plays a crucial role in improving limb coordination and shot precision over time. Moreover, Sakurai and Ohtsuki (2000) found that skilled players exhibit more consistent electromyographic activity in distal muscles, particularly the wrist flexors and extensors, which directly impacts smash accuracy. This finding underscores the importance of fine motor control, which is developed through structured technical drills. Additionally, Le Mansec et al. (2020) reported that muscle fatigue negatively affects smash performance, leading to decreased accuracy and shot speed, further reinforcing the necessity of physical conditioning to sustain high performance during prolonged play.

Taken together, these insights support the argument that a well-structured combination of physical and technical training is essential for competitive badminton performance. By addressing both explosive power and biomechanical precision, this training approach equips athletes with the necessary physical foundation and technical mastery to maintain accuracy under match conditions. Beyond improving smash execution, the integration of skipping drills and smash drills may also enhance overall match endurance, reduce fatigue-induced performance decline, and improve shot selection under pressure (Palamarchuk & Vaillancourt, 2021; Kent et al., 2018). In a high-intensity sport where milliseconds and millimeters can determine the outcome of a rally, such multifaceted training strategies may offer a critical advantage for athletes striving for consistency and dominance on the court.

The improvements observed in smash accuracy can be attributed to specific physiological and biomechanical adaptations resulting from the combined training regimen. Skipping drills likely played a pivotal role in developing lower-body strength, neuromuscular coordination, and postural stability, all of which are crucial for executing a powerful and precise smash (Lin et al., 2023; Gulati, 2024; Akbar, 2021). Studies indicate that repetitive jumping motions engage major muscle groups, such as the gastrocnemius, quadriceps, and hamstrings, which are key contributors to explosive power in jump smashes (Kardiawan, 2010; Cui & Wang, 2022). Additionally, skipping enhances proprioception and dynamic balance, which are essential for maintaining body control during the jump-to-land transition in a smash stroke (Solanki & Gill, 2021). Beyond its physical benefits, skipping may have indirectly contributed to timing and rhythm improvements, allowing athletes to achieve more synchronized movement patterns when preparing for a smash.

Complementing these gains, smash drills contributed to refining biomechanical efficiency and shot accuracy by optimizing the kinetic chain principle—where energy generated from the lower body is efficiently transferred through the upper body and into the racket (Kumar & Das, 2024). The repetitive execution of smash techniques likely helped improve racket control, shuttlecock placement, and shot timing, leading to greater consistency and precision in shot execution (Gatra et al., 2022). Prior studies have demonstrated that fine motor control in wrist movement and racket head alignment is crucial in optimizing energy transfer and maximizing shot velocity (Hung et al., 2020; Li et al., 2017; Darsono et al., 2023). This suggests that athletes in the experimental group not only developed greater strength and agility but also refined their technical execution, allowing them to generate more controlled yet forceful smashes.

Despite these compelling findings, it is important to acknowledge that the present study did not directly measure biomechanical changes or neuromuscular adaptations. While existing literature supports the idea that improved lower-body strength and refined kinetic chain efficiency contribute to enhanced shot accuracy, further research incorporating motion capture analysis, electromyography (EMG), or force plate assessments would be valuable in confirming the precise physiological changes occurring due to this training regimen. Additionally, while the study demonstrates that a combined training approach is superior to conventional methods, the extent to which these improvements translate to real-game conditions remains an open question. Since match performance involves additional variables such as opponent movement, tactical decision-making, and psychological pressure, future research should investigate whether accuracy gains in controlled settings translate to greater shot effectiveness during live match play (Escudero-Tena et al., 2021; Head et al., 2017).

This study confirms that a combined skipping and smash drill training regimen effectively enhances smash accuracy by integrating lower-body conditioning, neuromuscular coordination, and biomechanical refinement. The findings emphasize that technical precision alone is insufficient, as optimal shot execution requires a synergistic combination of physical power, balance, and motor control. While improvements were evident in controlled settings, their applicability to real-game scenarios remains uncertain, as factors like psychological pressure and tactical decision-making may influence accuracy under competition conditions. Future research should explore long-term training effects, skill transfer to match play, and advanced biomechanical assessments to deepen understanding of performance adaptations. From a practical perspective, these results suggest that coaches should adopt integrated training strategies, as combining physical conditioning with technical skill development may yield superior improvements compared to isolated methods. By refining training methodologies through evidence-based approaches, badminton athletes can develop greater accuracy, consistency, and competitive resilience.

Conclusions

This study demonstrates that the combination of skipping and smash drill training significantly improves smash accuracy among PB Garuda badminton players. Skipping enhances explosive power, stability, and neuromuscular coordination, while smash drills optimize biomechanics through the kinetic chain principle, enabling more efficient energy transfer during smashes. The integration of these methods offers a holistic approach that supports both technical mastery and physical conditioning. These findings provide evidence-based guidance for coaches to design effective training programs for improving smash accuracy, applicable across various competitive levels. Future studies are recommended to explore the optimal duration and intensity of training, as well as to test its effectiveness in real match situations to strengthen its practical applications.

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