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Improvement of technical-tactical movements of 11–13-year-old judoka through speed-strength training

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Annotation. *Speed-strength qualities – defined as the capacity to generate maximal force within minimal time remain underexplored in the technical-tactical development of young judoka. While the adult literature has examined explosive power in the context of throwing effectiveness, relatively little research has focused on the 11–13 age group, a period when sport-specific motor patterns become neurologically consolidated. This study followed 64 male judoka (mean age 12.1 ± 0.6 years) across a 20-week training intervention. Participants were allocated by stratified block randomisation to an experimental group receiving an augmented speed-strength protocol (EG, n = 32) or a control group continuing standard club training (CG, n = 32). Reactive strength index (RSI), peak power output, grip force, and a validated technical-tactical execution battery (TTEBJ) were assessed at baseline, week 10, and week 20. The EG showed greater improvements across all physical measures including a 18.4% increase in RSI ($p < 0.001$, $\eta^2 = 0.43$) and a 18.7% gain in grip force alongside significant advances in technique frequency and decision speed. RSI was the strongest correlate of TTEBJ composite score ($r = 0.54$, $p < 0.001$). These findings indicate that systematically integrating speed-strength training into early adolescent judo programmes may support meaningful improvements in technical-tactical performance.*

Keywords: *judo; speed-strength; technical-tactical skills; early adolescence; reactive strength index; explosive power; sports pedagogy; longitudinal intervention.*

Социально-педагогическая и психологическая сущность понятий предвидения и прогнозирования

Аннотация. *Скоростно-силовые качества, определяемые как способность развивать максимальное усилие за минимальное время, остаются недостаточно изученными в контексте формирования технико-тактического мастерства юных дзюдоистов. Несмотря на то, что в исследованиях, посвящённых взрослым спортсменам, изучалась роль взрывной силы в эффективности выполнения бросковой техники, влияние скоростно-силовой подготовки на спортсменов в возрасте 11–13 лет, когда происходит активное формирование и закрепление специфических двигательных навыков, исследовано недостаточно. В настоящем исследовании приняли участие 64 юных дзюдоиста мужского пола (средний возраст 12,1 ± 0,6 года), наблюдение за которыми проводилось в течение 20-недельного тренировочного цикла. Участники были распределены методом стратифицированной блочной рандомизации на экспериментальную группу (ЭГ, n*

= 32), выполнявшую дополнительную программу скоростно-силовой подготовки, и контрольную группу (КГ, n = 32), продолжавшую стандартные тренировочные занятия.

На исходном этапе, через 10 и 20 недель оценивались индекс реактивной силы (RSI), максимальная мощность, сила хвата кисти и результаты стандартизированной батареи тестов технико-тактического мастерства (TTEBJ). Спортсмены экспериментальной группы продемонстрировали более выраженное улучшение всех физических показателей, включая увеличение RSI на 18,4 % ($p < 0{,}001$; $\eta^2 = 0{,}43$) и силы хвата на 18,7 %, а также достоверный рост частоты технических действий и скорости принятия тактических решений. Наиболее сильная корреляционная связь с интегральным показателем TTEBJ была выявлена для индекса реактивной силы ($r = 0{,}54$; $p < 0{,}001$).

Полученные результаты свидетельствуют о том, что систематическое включение скоростно-силовой подготовки в программы обучения дзюдоистов раннего подросткового возраста способствует существенному повышению уровня их технико-тактической подготовленности.

Ключевые слова: *дзюдо; скоростно-силовые качества; технико-тактическое мастерство; ранний подростковый возраст; индекс реактивной силы; взрывная сила; спортивная педагогика; лонгитюдное исследование.*

Social, pedagogical and psychological essence of the concepts of foresight and forecasting

Annotatsiya. *Maqolada tezkor-kuch sifatlari – minimal vaqt ichida maksimal kuch hosil qilish qobiliyati sifatida tavsiflanib, yosh dzyudochilarning texnik-taktik tayyorgarligini rivojlantirishda hali yetarli darajada o‘rganilmagan yo‘nalishlardan biri hisoblanadi. Katta yoshdagi sportchilar ishtirokidagi tadqiqotlarda portlovchi kuchning uloqtirish usullarining samaradorligiga ta’siri keng yoritilgan bo‘lsa-da, sportga xos harakat ko‘nikmalari faol shakllanadigan va nevrologik jihatdan mustahkamlanadigan 11–13 yoshli dzyudochilarda ushbu masala bo‘yicha ilmiy izlanishlar nisbatan kam uchraydi. Mazkur tadqiqotda o‘rtacha yoshi 12,1 ± 0,6 bo‘lgan 64 nafar o‘g‘il bola dzyudochi 20 hafta davomida kuzatildi. Ishtirokchilar stratifikatsiyalangan blokli randomizatsiya usuli asosida tajriba guruhi (TG, n = 32), ya’ni qo‘shimcha tezkor-kuch mashg‘ulotlari dasturini bajargan sportchilar va nazorat guruhi (NG, n = 32), ya’ni odatiy klub mashg‘ulotlarini davom ettirgan sportchilarga ajratildi.*

Tadqiqotning boshlanishida, 10-haftada va 20-haftada reaktiv kuch indeksi (RSI), maksimal quvvat ko‘rsatkichi, qo‘l panjasi ushlash kuchi hamda texnik-taktik harakatlarni bajarish bo‘yicha validatsiyadan o‘tgan testlar majmuasi (TTEBJ) baholandi. Tajriba guruhi barcha jismoniy ko‘rsatkichlar bo‘yicha nazorat guruhiga nisbatan sezilarli darajada yuqori natijalarga erishdi. Jumladan, reaktiv kuch indeksi 18,4 % ga ($p < 0{,}001$; $\eta^2 = 0{,}43$), qo‘l panjasi ushlash kuchi esa 18,7 % ga oshdi. Shuningdek, texnik usullarni bajarish chastotasi va taktik qaror qabul qilish tezligida ham ishonchli ijobiy o‘zgarishlar kuzatildi. TTEBJ umumiy ko‘rsatkichi bilan eng kuchli korrelyatsiya reaktiv kuch indeksida qayd etildi ($r = 0{,}54$; $p < 0{,}001$).

Tadqiqot natijalari shuni ko‘rsatadiki, tezkor-kuch mashqlarini erta o‘smirlik davridagi dzyudochilarning mashg‘ulot dasturlariga tizimli ravishda integratsiya qilish ularning texnik-taktik tayyorgarligini sezilarli darajada takomillashtirishga xizmat qiladi.

Kalit so‘zlar: *dzyudo; tezkor-kuch sifatlari; texnik-taktik ko‘nikmalar; erta o‘smirlik davri; reaktiv kuch indeksi; portlovchi kuch; sport pedagogikasi; uzun muddatli tadqiqot.*

INTRODUCTION

Physical preparation and technical-tactical instruction are often treated as separate tracks in youth judo curricula, yet the physical qualities that underpin elite performance explosive force, reactive precision, and the capacity to sustain high-intensity efforts also constrain the acquisition of technique when underdeveloped in adolescent athletes. This relationship has been acknowledged by practitioners for decades, but the scientific literature has addressed it only partially. The present study was designed to examine it directly in a cohort of 11–13-year-old male judoka. At the senior level, the demands of judo are well characterised. Bouts consist of brief, high-intensity exchanges typically two to four seconds per attack separated by moderate-intensity gripping and positional contest. Scoring success depends less on aerobic capacity or raw strength than on the ability to apply force rapidly and precisely under competitive pressure. This quality is indexed by reactive strength the capacity to transition quickly from eccentric to concentric muscular action which has been consistently associated with ippon-scoring frequency and throw execution quality in seoi-nage, uchi-mata, and o-soto-gari.

The 11–13 age range is a period of accelerated neural maturation, variable somatic growth, and widening performance gaps between athletes who receive structured physical preparation and those who do not reported that explosive power interventions delivered before peak height velocity produced larger gains than equivalent interventions applied post-pubertally, consistent with a sensitive period for speed-strength development. Despite this, the application of these principles to judo training in this age group has not been adequately investigated in the peer-reviewed literature. Previous studies of physical performance in young judoka have been largely cross-sectional. Pococco et al. and Detanico et al. Established useful normative data on strength and power but did not examine whether targeted conditioning translates into improved technical execution. A longitudinal study by Casals et al. Found significant plyometric training effects on jump performance in 12-year-old wrestlers, but did not assess technical outcomes in a martial arts context. How speed-strength qualities relate to the development and expression of judo technique in early adolescence therefore remains an open question. The theoretical basis for this investigation draws on two complementary frameworks. The dynamic systems perspective treats technique as emerging from the interaction between the athlete's physical capacities and the movement problem at hand, positioning strength and coordination as co-contributors to skilled action rather than independent qualities. The constraint-led approach to pedagogy similarly suggests that modifying the physical load characteristics of training tasks can direct technical learning without relying on explicit instruction. Both frameworks predict that improving the physical basis of force production should expand the range of technically viable options available to a young judoka.

The pattern of subscale correlations provides some insight a 20-week augmented speed-strength protocol, integrated within standard judo training, produced greater improvements in physical performance and technical-tactical execution than conventional training alone. A secondary aim was to characterise the relationships between specific speed-strength measures particularly RSI and peak grip force and validated technical-tactical proficiency. We hypothesised that the EG would show larger gains across both physical and technical domains, and that RSI would be the strongest physical predictor of technical performance.

METHODS

Sixty-four male judoka were recruited from four sports schools in the Tashkent region of Uzbekistan. Inclusion criteria required active competitive status at a minimum of 5th kyu grade, at least 18 months of judo training, and age between 11 and 13 years at baseline. Exclusion criteria were: musculoskeletal injury in the preceding three months, concurrent participation in an external resistance training programme, or a body mass index exceeding the 85th age- and sex-specific percentile. All 64 participants met inclusion criteria following preliminary health screening. Participants were allocated to the experimental group (EG, n = 32) or control group (CG, n = 32) using stratified block randomisation, with strata defined by age subgroup (11, 12, and 13 years) and training experience duration. Allocation was performed via computer-generated random numbers by a researcher not involved in the delivery of the intervention. At baseline, group characteristics were comparable. The EG comprised athletes with mean age 12.1 ± 0.7 years, body mass 44.3 ± 5.2 kg, height 153.1 ± 7.4 cm, and training experience 2.6 ± 0.8 years. Corresponding CG values were 12.0 ± 0.6 years, 43.9 ± 4.8 kg, 152.4 ± 6.9 cm, and 2.5 ± 0.7 years. Independent-samples t-tests confirmed no significant baseline differences on any variable (all $p > 0.42$). Written informed consent was obtained from parents or legal guardians of all participants. The study was approved by the Renaissance University of Education ethics committee (protocol reference: RUE-2025/4), in accordance with the Declaration of Helsinki.

A pretest–posttest randomised controlled design with an intermediate measurement point was employed. The 20-week intervention comprised two mesocycles of 10 weeks each, with full test batteries administered at weeks 0, 10, and 20. Both groups continued their regular club technical-tactical training at the same volume, delivered by the same two coaches (both IJF Level 2 certified), ensuring that differences in technical instruction were minimised. The EG received an additional 45-minute speed-strength session twice per week, replacing an equivalent period of unstructured conditioning that the CG undertook. Blinding of coaches was not feasible, but assessors administering the physical and technical batteries were kept unaware of group allocation throughout the study.

The speed-strength protocol followed a progressive overload model, drawing on evidence-based guidelines for youth explosive power development. Each session rotated across four training categories: reactive plyometric drills focused on minimising ground contact time (e.g., drop jumps from a 30 cm platform, bounding sequences); judo-specific resistance exercises targeting the pulling musculature (barbell and dumbbell rows, lat pulldowns, weighted sleeve-grip rows); contrast training pairing a loaded movement with an unloaded explosive equivalent (e.g., weighted partner lifts followed by shadow uchi-mata); and reactive agility tasks requiring rapid directional changes to visual stimuli.

Weeks 1–4 constituted an introductory phase with moderate volume and low-to-moderate intensity, prioritising technique acquisition for novel exercises. Weeks 5–10 involved progressive intensity increases of approximately 5% per two-week block and shorter rest periods. The second mesocycle (weeks 11–20) shifted toward judo-specific application, incorporating tatami-based reactive drills in the judogi, partner resistance work replicating kumi-kata scenarios, and decision-making tasks embedded within speed-strength sequences. Total weekly training hours were equivalent across groups, confirming that volume differences did not confound the comparison.

Four instruments assessed physical performance. RSI was derived from drop jumps performed on a calibrated force plate, computed as jump height divided by ground contact time a standard measure of stretch-shortening cycle efficiency. Peak anaerobic power was estimated from a 30-second Wingate test on a cycle ergometer (Monark 894E), using body-mass-adjusted loading protocols for this age group Isometric grip force was measured bilaterally with a hand dynamometer (Jamar Plus+, Patterson Medical), using the mean of three trials per hand. Lower-limb explosive force was assessed via countermovement jump (CMJ) height on the same force plate, following the protocol described by Moir et al.

Technical-tactical proficiency was assessed using the Technical-Tactical Execution Battery for Young Judoka (TTEBJ), developed and validated by Tursunov et al. The TTEBJ includes three components: a randori performance score (attack frequency, technique variety, and scoring effectiveness across two three-minute rounds against a standardised sparring partner); a video-based decision latency task (athletes view 30-second match excerpts and indicate their technique choice via response pad); and a solo kata evaluation scored by two certified assessors using a standardised rubric (ICC = 0.91; 95% CI: 0.87–0.94). The composite TTEBJ score (0–100) has demonstrated acceptable test-retest reliability ($r = 0.88$, $p < 0.001$) and construct validity against senior coach ratings ($r = 0.79$, $p < 0.001$).

All analyses were performed using IBM SPSS Statistics v29.0. A priori power analysis (G*Power 3.1) indicated that 64 participants (32 per group) would provide 80% power to detect a medium interaction effect ($f = 0.25$) in a 2 × 3 mixed ANOVA at $\alpha = 0.05$; the final sample exceeded this requirement. Data normality was confirmed via Shapiro-Wilk tests (all $p > 0.05$ at baseline). Group differences across time were examined using 2 (group) × 3 (time) mixed-design ANOVA with Bonferroni-corrected post-hoc comparisons. Effect sizes were reported as partial eta-squared (η^2), with benchmarks of 0.01 (small), 0.06 (medium), and 0.14 (large) following Cohen (1988). Within-group changes were characterised using paired t-tests with Cohen's d where significant interactions were found. Pearson correlations examined associations between speed-strength indices and TTEBJ scores at week 20. Hierarchical multiple regression, with predictors entered in theoretically motivated blocks, was used to identify independent physical predictors of technical-tactical performance. Statistical significance was set at $\alpha = 0.05$. Missing data were minimal (< 2%) and handled by listwise deletion.

RESULTS AND DISCUSSION

The mixed ANOVA revealed a significant group × time interaction for RSI ($F(2, 124) = 47.3$, $p < 0.001$, $\eta^2 = 0.43$), indicating divergent trajectories across the 20-week period. RSI values at baseline did not differ between the EG (1.42 ± 0.21) and CG (1.39 ± 0.19; $p = 0.52$). By week 10, the EG had increased to 1.61 ± 0.23, while the CG showed a smaller gain (1.46 ± 0.18). At week 20, the EG reached 1.82 ± 0.25 (a 28.4% increase from baseline), compared with 1.52 ± 0.20 in the CG (9.4% gain). The between-group difference at week 20 was significant ($t(62) = 5.71$, $p < 0.001$, $d = 1.43$). Similar patterns were observed for the remaining physical variables, with somewhat smaller effect sizes. Peak Wingate power increased from 5.84 ± 0.72 to 7.12 ± 0.81 W/kg in the EG (21.9% gain) versus 5.79 ± 0.68 to 6.18 ± 0.70 W/kg in the CG (6.7% gain; $\eta^2 = 0.39$, $d = 1.21$). Dominant-hand grip force rose from 23.4 ± 3.1 to 28.7 ± 3.6 kg in the EG (22.7% gain) versus 23.1 ± 2.9 to 24.8 ± 3.0 kg in the CG (7.4% gain; $\eta^2 = 0.36$, $d = 1.11$). CMJ height increased from 28.6 ± 3.4 to 34.9 ± 4.1 cm in the EG (22.0% gain) versus 28.3 ± 3.2 to 30.1 ± 3.5 cm in the CG (6.4% gain; $\eta^2 = 0.41$, $d = 1.18$). Results are summarised in Table 1.

Table 1.

Mean (± SD) physical performance values by group and time point.

Variable	EG Baseline	EG Wk10	EG Wk20	CG Baseline	CG Wk10	CG Wk20
RSI (ratio)	1.42 ± 0.21	1.61 ± 0.23	1.82 ± 0.25*	1.39 ± 0.19	1.46 ± 0.18	1.52 ± 0.20
Peak Power (W/kg)	5.84 ± 0.72	6.52 ± 0.76	7.12 ± 0.81*	5.79 ± 0.68	5.97 ± 0.69	6.18 ± 0.70
Grip Force (kg)	23.4 ± 3.1	26.2 ± 3.4	28.7 ± 3.6*	23.1 ± 2.9	23.8 ± 2.9	24.8 ± 3.0
CMJ Height (cm)	28.6 ± 3.4	31.8 ± 3.8	34.9 ± 4.1*	28.3 ± 3.2	29.0 ± 3.3	30.1 ± 3.5

*EG = experimental group; CG = control group; RSI = reactive strength index; CMJ = countermovement jump. *p < 0.001 for between-group difference at week 20.*

Group × time interactions were significant and large for all TTEBJ components and for the composite score. The EG composite score increased from 54.7 ± 6.8 at baseline to 72.4 ± 7.3 at week 20 (32.4% improvement), while the CG progressed from 54.2 ± 6.5 to 61.8 ± 6.9 (14.0% gain; $F(2, 124) = 38.6$, $p < 0.001$, $\eta^2 = 0.38$, $d = 1.54$). Table 2 presents component scores across time points. On the randori subscale, ippon attempt frequency in the EG increased by 41.3% (from 3.2 ± 0.8 to 4.5 ± 0.9 per three-minute round), and the proportion of attempts judged technically sound rose from 38% to 63%. In the CG, attempt frequency increased by 15.6% (3.2 ± 0.7 to 3.7 ± 0.8) and technique quality from 37% to 46%. Mean response time on the decision latency task decreased by 19.2% in the EG (from 1.04 ± 0.18 s to 0.84 ± 0.15 s) compared with 7.7% in the CG (1.03 ± 0.17 s to 0.95 ± 0.16 s).

Table 2.

TTEBJ component and composite scores (mean ± SD) across measurement time points.

TTEBJ Component	EG BL	EG Wk10	EG Wk20	CG BL	CG Wk10	CG Wk20
Randori Score (/40)	20.8 ± 3.1	26.1 ± 3.4	29.7 ± 3.6*	20.6 ± 2.9	22.4 ± 3.0	24.1 ± 3.2
Decision Latency (/30)	16.4 ± 2.4	19.8 ± 2.6	22.3 ± 2.7*	16.2 ± 2.3	17.3 ± 2.4	18.6 ± 2.5
Kata Evaluation (/30)	17.5 ± 2.2	20.6 ± 2.5	20.4 ± 2.4*	17.4 ± 2.2	18.1 ± 2.3	19.1 ± 2.3
Composite (/100)	54.7 ± 6.8	66.5 ± 7.1	72.4 ± 7.3*	54.2 ± 6.5	57.8 ± 6.7	61.8 ± 6.9

BL = baseline. *p < 0.001 for between-group difference at week 20.

Pearson correlations at week 20 showed that RSI had the strongest association with TTEBJ composite score ($r = 0.74$, $p < 0.001$), followed by peak Wingate power ($r = 0.67$, $p < 0.001$), grip force ($r = 0.61$, $p < 0.001$), and CMJ height ($r = 0.58$, $p < 0.001$). At the subscale level, RSI was most strongly associated with randori performance ($r = 0.76$, $p < 0.001$), grip force with kata evaluation ($r = 0.63$, $p < 0.001$), and Wingate peak power with decision latency ($r = 0.64$, $p < 0.001$). Hierarchical multiple regression identified RSI ($\beta = 0.46$, $p < 0.001$) and grip force ($\beta = 0.29$, $p = 0.003$) as significant predictors of TTEBJ composite score in Block 1, together accounting for 67% of variance ($R^2 = 0.67$, $F(2, 61) = 62.2$, $p < 0.001$). Adding peak power in Block 2 did not significantly increase explained variance ($\Delta R^2 = 0.03$, $p = 0.09$). These results indicate that athletes with greater RSI gains and higher grip force showed the largest improvements in technical-tactical performance.

The main finding of this study is that a 20-week speed-strength protocol, delivered twice weekly within standard judo training, produced larger gains in technical-tactical performance than conventional training alone. RSI accounted for approximately 55% of the variance in TTEBJ composite scores at week 20, suggesting that stretch-shortening cycle efficiency is a important factor of technical execution in this age group. This association is correlational in nature, and further research is needed to establish whether RSI improvements precede or co-develop alongside technical gains. The correlations between variables give some idea of what might be happening.. RSI was most strongly associated with randori performance the most more realistic part of the test of the battery rather than with kata evaluation, which involves more deliberate, lower-velocity movements. In competitive randori, a throwing opportunity typically persists for under 200 milliseconds (Imamura et al., 2007). Exploiting it requires detecting a postural opening, committing to a technique, and initiating an explosive pulling-rotating movement before the window closes. RSI reflects precisely this capacity for rapid force production. The 28.4% RSI gains in the EG over 20 weeks are consistent with those reported by Mero et al. Following plyometric training in 12-year-old soccer players (19–24%), though direct comparisons are limited by differences in measurement protocols and sport demands. The grip force findings are of practical relevance. The 22.7% gain in dominant-hand grip force in the EG, combined with its preferential association with kata scores, points to the role of pulling strength in technically precise throw execution. Previous studies have noted that young judoka with limited pulling strength tend to over-rely on leg drive in throws such as o-goshi and seoi-nage, producing technique that is mechanically less efficient and easier to counter. The contrast training component of the protocol linking loaded pulling exercises to immediate judo-specific applications appears to have supported the transfer of strength gains to technique, which is consistent with post-activation potentiation mechanisms described by Docherty et al.

The 19.2% reduction in decision latency among EG athletes is also noteworthy. Decision speed in judo is often treated as a purely cognitive variable, yet the regression analysis identified peak anaerobic power as a significant correlate. One plausible explanation is that higher anaerobic capacity sustains prefrontal activation during high-intensity randori, reducing attentional decline under fatigue. Pococco et al. Proposed a similar relationship in senior athletes; the present data suggest it may be detectable even before the adolescent growth spurt amplifies anaerobic capacity. Casals et al. Demonstrated plyometric training effects on power in young wrestlers but found no transfer to competitive performance, likely because their outcome measure competition ranking conflates physical, technical, and tactical contributions. Detanico et al. Reported smaller correlations between grip strength and skill in cross-sectional data ($r \approx 0.48$) than those found here ($r = 0.61$), which may reflect the advantage of the TTEBJ's disaggregated structure over holistic competition indices. It should be noted that the CG also improved across 20 weeks, which is expected. Repeated throw execution develops the pulling and rotating musculature, and randori itself imposes reactive demands. The periodisation structure of the intervention also merits comment. Organising the programme as two sequential mesocycles the first building physical capacity, the second emphasising judo-specific application of those qualities follows an established principle in transfer-of-training research: physical gains acquired in general contexts must be re-expressed in task-specific ones to maximise their contribution to skilled performance. The acceleration of TTEBJ gains in weeks 11–20 relative to the first mesocycle is consistent with this interpretation. Several limitations should be acknowledged. The all-male sample limits generalisability to female judoka, whose motor development and physiological responses in this age range differ in relevant ways. Recruitment was restricted to four schools in the Tashkent region, and the findings may not transfer to contexts with different coaching quality or resource access. The 20-week follow-up cannot speak to the persistence of gains over subsequent competitive seasons. Future studies should incorporate female participants, multi-site designs, and longer follow-up periods.

CONCLUSION

A 20-week speed-strength protocol integrated into early adolescent judo training produced physical gains consistent with the sensitive period for this quality in pre- and early-pubertal athletes, and these gains were accompanied by significant improvements across all components of a validated technical-tactical assessment. RSI and grip force were the strongest physical correlates of technical performance, accounting for 67% of variance in TTEBJ composite scores. For practitioners, the implication is that separating physical conditioning from technical-tactical instruction in the 11–13 age group represents a missed developmental opportunity. Integrating speed-strength work through contrast methods and reactive applications ensuring that physical gains are immediately re-expressed in judo-specific contexts appears to be a more effective approach than treating the two as parallel tracks. This study adds to the growing body of evidence that physical and skill development in combat sports are more interdependent than many long-term athlete development models have assumed.

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