

Effects of Structured Psychological Recovery Interventions on Training Fatigue and Motivation in Taekwondo Students: A Single Group Pre-Post Study

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Abstract: **Background:** Repetitive taekwondo training produces Training Fatigue (TF), cognitive and emotional depletion from overexposure to routine practice. Structured in-session psychological recovery interventions to address this remain largely untested in martial arts. **Purpose:** To evaluate the effects of breathwork, guided visualization, and micro-breaks on training fatigue, intrinsic motivation, and perceived stress in adult taekwondo students over 4 weeks. **Method:** A single-group pre-post design was employed. Thirty adults (23 male, 7 female; M = 22.27 years, SD = 2.49, range = 18–26) from a Bangalore taekwondo academy received a 3–5-minute recovery activity at session start across 4 weeks. Outcomes were measured at baseline (Week 0) and post-intervention (Week 4) using the PSS-10, SMS-II intrinsic motivation subscale, and the Training Fatigue Scale (TFS), an 8-item scale developed for this study. Shapiro-Wilk tests determined test selection; analyses used paired *t*-tests, Wilcoxon signed-rank tests, and Spearman correlation. **Results:** Training fatigue did not decrease significantly, $t(29) = 1.03$, $p = .313$, $d = 0.19$ (H1 not supported). Intrinsic motivation increased significantly, $W = 64.00$, $p = .023$, $d = 0.44$ (H2 supported). Perceived stress decreased significantly, $W = 51.00$, $p = .007$, $d = 0.37$. Fatigue-motivation correlation was weak and non-significant, $\rho = -0.204$, $p = .280$. TFS internal consistency was acceptable ($\alpha = .80$, $.78$). **Conclusion:** The intervention improved motivation and stress but did not reduce training fatigue within 4 weeks. Brief recovery activities function as motivational primers rather than fatigue-reduction tools over short intervention windows.

Keywords: taekwondo, training fatigue, breathwork, guided visualization, micro-breaks, intrinsic motivation, self-determination theory.

1. Introduction

A. Background of the Study

Taekwondo, a Korean martial art known for its dynamic kicking techniques and disciplined practice structure, is both a competitive sport and a developmental activity that fosters physical, cognitive, and psychological growth (World Taekwondo, 2023). Like many martial arts, it relies heavily on repetition, through poomsae (forms), drills, and conditioning exercises as a pathway to mastery (Vertonghen & Theeboom, 2010). While deliberate repetition builds skill precision and

automaticity, it also creates psychological challenges when training becomes monotonous or predictable.

These challenges are explained by Cognitive Load Theory (CLT; Sweller, 1988), which holds that working memory has a finite capacity for processing information. When tasks are highly repetitive, extraneous cognitive load accumulates, resulting in reduced processing efficiency, disengagement, and fatigue. Over time, this contributes to mental fatigue, a psychobiological state characterized by tiredness, reduced attentional control, and diminished motivation to continue (Van Cutsem et al., 2017; Boksem & Tops, 2008). In the context of sport training, this fatigue is compounded by the emotional demands of sustained engagement with the same content across sessions (Goodger et al., 2007; Maslach et al., 2001).

Mental fatigue is closely associated with emotional exhaustion: the depletion of emotional resources that leaves athletes feeling unable to cope with training demands (Maslach & Jackson, 1981). Together, these dimensions constitute what this study terms Training Fatigue (TF), a state of cognitive and emotional depletion arising specifically from overexposure to repetitive practice. TF is operationalized through a purpose-built 8-item Training Fatigue Scale (TFS), drawing on established fatigue and emotional exhaustion constructs in sport psychology literature.

The Psychobiological Model of Mental Fatigue (Marcora et al., 2009) explains that exhaustion during repetitive training is driven primarily by the subjective perception of effort rather than physiological depletion. When taekwondo students repeatedly cycle through familiar routines, perceived effort rises and willingness to persist declines, even when physical capacity remains intact (Pageaux, 2016). While deliberate practice is essential for expertise development (Ericsson et al., 1993; Ericsson, 2006), unchecked monotony risks eroding motivation and long-term engagement.

B. Problem Statement

Despite the necessity of repetition in martial arts training, the psychological costs of monotonous practice remain

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underexplored in the literature. Evidence from sport psychology and occupational settings shows that repetitive task environments contribute to mental fatigue, loss of motivation, and burnout (Cresswell & Eklund, 2005; Gustafsson *et al.*, 2007; Raedeke, 1997). For young adult practitioners, these effects are particularly consequential: motivation is a primary determinant of continued sport participation, and disengagement during early training years often predicts dropout (Gould *et al.*, 1996; Côté & Fraser-Thomas, 2007).

Training Fatigue provides a useful conceptual lens for understanding this problem. Unlike overtraining syndrome, which is rooted in physiological overload (Kreher & Schwartz, 2012; Meeusen *et al.*, 2013), or general life stress (Lazarus & Folkman, 1984), TF emerges specifically from the monotony and predictability of repetitive training content (Raedeke, 1997; Smith, 1986). In taekwondo, where forms, sparring drills, and conditioning are performed repeatedly across each session, students are particularly vulnerable to this type of fatigue. Left unaddressed, TF may erode intrinsic motivation, reduce training quality, and ultimately contribute to dropout.

C. Rationale of the Study

Eliminating repetition from taekwondo training is neither realistic nor desirable. The challenge lies in buffering students against the psychological strain of monotony while preserving the benefits of deliberate practice. Brief psychological recovery strategies, specifically breathwork, guided visualization, and micro-breaks, have demonstrated effectiveness in reducing fatigue and sustaining motivation across performance and learning contexts (Balban *et al.*, 2023; Cumming & Williams, 2013; Wendsche & Lohmann-Haislah, 2022; Hunter & Wu, 2016). These techniques require no equipment, add minimal time to sessions, and can be delivered by coaches without specialist training.

Despite their potential, such strategies have rarely been tested in martial arts training environments. This study addresses that gap by embedding a structured rotating toolkit of recovery activities into 4 weeks of taekwondo training and examining pre-to-post changes in training fatigue, perceived stress, and intrinsic motivation. The 4-week timeframe is a pragmatic and feasible window for an exploratory study, consistent with evidence that brief breathwork and micro-break interventions can produce detectable psychological effects within comparable durations (Balban *et al.*, 2023; Kim *et al.*, 2022).

D. Significance of the Study

Theoretically, this study contributes to sport and counseling psychology by framing Training Fatigue as a construct that differentiates monotony-driven exhaustion from broader burnout or stress. By testing a structured recovery toolkit, the study applies and extends three established theoretical frameworks, CLT (Sweller, 1988), the Psychobiological Model (Marcora *et al.*, 2009), and Self-Determination Theory (SDT; Ryan & Deci, 2000), in an underexplored real-world training context.

Practically, the study generates a coach-deliverable intervention protocol that requires no specialist resources and

can be adapted for any repetitive-training sport environment. For counseling psychology practitioners, findings speak to the role of brief self-regulation techniques as preventive tools for young adult athlete mental health and well-being (Moran & Toner, 2017; Williams & Krane, 2021). Positive outcomes support the case for integrating psychological recovery into routine coaching practice at the grassroots level.

E. Aims of the Study

The primary aim of this study is to evaluate the effects of structured psychological recovery interventions breathwork, guided visualization, and micro-breaks on Training Fatigue (TF) and training motivation among adult taekwondo students over a 4-week intervention period.

F. Objectives

- Assess within-participant changes in TF, intrinsic motivation, and perceived stress from baseline (Week 0) to post-intervention assessment (Week 4).
- Examine the statistical significance and practical effect size of these changes using paired inferential tests.
- Explore the relationship between changes in TF and changes in intrinsic motivation across the intervention period.

G. Research Questions

1. Does a 4-week structured psychological recovery intervention reduce Training Fatigue among adult taekwondo students?
2. Does the intervention enhance intrinsic training motivation compared to baseline?
3. How do changes in TF relate to changes in motivation and perceived stress over the intervention period?

H. Hypotheses

H1: Participants will exhibit significantly lower TFS scores at post-intervention assessment (Week 4) compared to baseline (Week 0).

H2: Participants will report significantly higher intrinsic motivation (SMS-II scores) at post-intervention assessment (Week 4) compared to baseline (Week 0).

2. Review of Literature

A. Theoretical Framework

This study is grounded in three complementary psychological frameworks that together account for the cognitive, motivational, and psychobiological dimensions of training fatigue and recovery in repetitive sport contexts.

Cognitive Load Theory (CLT; Sweller, 1988, 1994) provides the cognitive foundation. CLT proposes that working memory has a finite capacity and that learning tasks generate three forms of cognitive load: intrinsic (inherent task complexity), extraneous (arising from task design), and germane (supporting schema formation; Paas *et al.*, 2003). In repetitive training environments, extraneous load accumulates as learners process familiar stimuli without meaningful variation, progressively

reducing efficiency, attention, and engagement (Kalyuga, 2011). Applied to taekwondo, where the same poomsae and conditioning drills are repeated across sessions, CLT predicts progressive cognitive overload that manifests as fatigue and withdrawal. Structured recovery activities theoretically function by reducing extraneous load—providing a cognitive disengagement window that allows working memory to reset (Schmidt & Lee, 2011).

The Psychobiological Model of Mental Fatigue (Marcora *et al.*, 2009) extends this account by positioning exhaustion primarily as a perceptual rather than physiological phenomenon. According to this model, performance degradation reflects the subjective experience of effort rather than depletion of physical resources. Marcora *et al.* (2009) demonstrated that mentally fatigued participants showed significant impairment in endurance performance despite unchanged physiological capacity, confirming that the locus of fatigue is largely cognitive and motivational (Martin *et al.*, 2018; Pageaux & Lepers, 2018).

Self-Determination Theory (SDT; Ryan & Deci, 2000, 2017) provides the motivational framework. SDT identifies three fundamental psychological needs: autonomy, competence, and relatedness, whose satisfaction supports intrinsic motivation (Deci *et al.*, 1999). Training environments that are highly prescriptive, offer limited novelty, and provide few opportunities for mastery can undermine perceived competence and autonomy, eroding intrinsic motivation and increasing susceptibility to disengagement (Ntoumanis, 2001; Standage *et al.*, 2003; Vallerand, 1997). Recovery interventions such as breathwork and guided imagery may support SDT needs by providing students with tools for self-regulation. Together, these three frameworks provide a multi-level rationale for the present study.

B. Training Fatigue and Exhaustion in Sport

Mental fatigue and emotional exhaustion have been extensively studied in elite sport, with growing attention to their impact on motivation, decision-making, and performance. Van Cutsem *et al.* (2017) conducted a systematic review and meta-analysis confirming that mental fatigue consistently impairs endurance performance, reaction time, and accuracy across sport types. Their analysis indicated that these effects are primarily perceptual rather than physiological, consistent with Marcora's model. A subsequent meta-analysis (Van Cutsem *et al.*, 2023) replicated these findings, reporting that self-paced effort and motivational states are among the most sensitive outcomes to fatigue accumulation. Smith *et al.* (2016) further demonstrated that mental fatigue impairs soccer-specific technical performance, while Badin *et al.* (2016) showed similar effects in small-sided games, confirming the relevance of mental fatigue across sport types.

In young adult and recreational sport contexts, the consequences of sustained fatigue extend beyond performance to retention and well-being. Gould *et al.* (1996) identified psychological exhaustion as a core predictor of burnout and dropout in junior tennis players, emphasizing that athletes disengage primarily for psychological rather than physical

reasons. Raedeke (1997) extended this work with his sport commitment model, arguing that athletes who feel entrapped by training obligations rather than intrinsically engaged are most vulnerable to burnout. Raedeke and Smith (2001) subsequently developed a validated athlete burnout measure showing that emotional exhaustion is the primary dimension of sport burnout, consistent with the present study's operationalization of TF.

Maslach and Jackson (1981) identified emotional exhaustion as the core dimension of burnout in their foundational occupational research. This construct has been widely applied in sport psychology (Cresswell & Eklund, 2005; Goodger *et al.*, 2007; Maslach *et al.*, 2001) and underpins the emotional exhaustion component of TF as operationalized in the TFS. Gustafsson *et al.* (2007) reported a burnout prevalence of 9–21% among competitive adolescent athletes, while Smith (1986) provided a cognitive-affective model of athletic burnout that frames exhaustion as the endpoint of stress appraisal processes, underscoring the real-world significance of addressing psychological exhaustion early. Coakley (1992) similarly argued that burnout in young athletes reflects not personal failure but structural features of sport environments among which monotonous, repetitive training is a key risk factor.

C. Breathwork and Psychological Recovery

Controlled breathing has a well-established evidence base as a rapid and practical stress regulation tool. Zaccaro *et al.* (2018) synthesized findings from 15 controlled studies on slow-breathing protocols and reported consistent reductions in sympathetic nervous system arousal, anxiety, and negative affect, alongside improvements in sustained attention and parasympathetic tone. Neurophysiological mechanisms include modulation of locus coeruleus activity and vagal afferent signaling, which directly influence arousal, attentional control, and mood (Melnychuk *et al.*, 2018; Russo *et al.*, 2017). Perciavalle *et al.* (2017) further demonstrated that deep breathing reduces cortisol and perceived stress in healthy adults, while Brown and Gerbarg (2005) established neurophysiological pathways through which yogic breathing reduces sympathetic arousal.

In a rigorous randomized controlled trial, Balban *et al.* (2023) showed that daily breathwork, particularly cyclic sighing, produced significantly greater reductions in self-reported stress and negative affect than mindfulness meditation, even with practice durations of as little as five minutes per day. Ma *et al.* (2017) similarly demonstrated that diaphragmatic breathing significantly reduced negative affect and stress in healthy adults, with effects emerging after a single session. Brown and Ryan (2003) showed that mindful present-moment attention, a state facilitated by breathwork, is a robust predictor of psychological well-being and reduced negative affect.

Box breathing (4-4-4-4), selected for the present intervention, has been employed in high-performance settings to reduce pre-task arousal and improve cognitive focus under stress (Jerath *et al.*, 2015; Gould & Udry, 1994). Its balanced rhythm promotes respiratory sinus arrhythmia and has

demonstrated acute reductions in perceived anxiety in practitioner samples, making it well-suited for delivery at the start of taekwondo sessions.

D. Guided Imagery and Motivation in Martial Arts

Mental imagery has a robust empirical foundation in sport psychology. Cumming and Williams (2013) proposed the Revised Applied Model of Deliberate Imagery Use, characterizing imagery as functioning across cognitive, motivational, and affective domains simultaneously (Martin *et al.*, 1999; Morris *et al.*, 2005). Athletes who engage in systematic mental simulation of successful performance demonstrate improvements in confidence, concentration, effort attribution, and intrinsic motivation, mediated by the functional equivalence of mental and physical execution at the neural level (Schuster *et al.*, 2011; Paivio, 1985).

In combat sport contexts, Slimani *et al.* (2016) reviewed psychophysiological interventions across 18 studies including taekwondo, finding that guided imagery was consistently associated with improved technical accuracy, focus, and confidence. These effects are directly relevant to Training Fatigue: if imagery reduces perceived effort and re-engages students' intrinsic interest in their own skill execution, it may serve as an effective counter to monotony-driven disengagement. Hagger and Chatzisarantis (2007) reviewed SDT and imagery in exercise and sport, finding that motivational imagery is most effective when targeting personal mastery and enjoyment rather than external outcomes. Choi *et al.* (2021) demonstrated that structured psychological skills work within taekwondo training enhances resilience and perceived stress management, confirming the environment's receptivity to embedded psychological skill development.

E. Micro-Breaks and Fatigue Reduction

Micro-breaks brief, intentional pauses from task engagement are among the most practically scalable fatigue-management strategies available to practitioners. Wendsche and Lohmann-Haislah (2022) conducted a meta-analysis of 83 studies concluding that micro-breaks of 10 minutes or less significantly reduced fatigue and improved vigour, mood, and performance when structured to permit genuine cognitive disengagement. Trougakos and Hideg (2009) showed that the effectiveness of micro-breaks depends on their content, with detachment-promoting activities producing greater recovery than work-related activities. Hunter and Wu (2016) extended this by showing that passive rest produces stronger recovery effects when pre-break fatigue is elevated.

Kim *et al.* (2022) found that structured 3-minute micro-breaks reduced subjective fatigue and improved accuracy in repetitive cognitive task environments. Kenttä and Hassmén (1998) argued that psychological recovery distinct from physiological rest is essential for sustained athletic performance, and that brief recovery windows embedded within training are more effective than extended rest periods after fatigue has accumulated. Kellmann (2010) and Kellmann *et al.* (2018) further established consensus criteria for recovery monitoring in sport, emphasizing that brief, regular

psychological recovery strategies are an evidence-based component of athlete well-being management.

F. Research Gap

Two gaps in the existing literature motivate the present study. First, the majority of fatigue and recovery research is conducted in elite sport or workplace settings (Van Cutsem *et al.*, 2017; Wendsche & Lohmann-Haislah, 2022), with limited attention to everyday young adult martial artists. The specific training culture of taekwondo—characterized by high repetition, form-based practice, and authority-structured coaching relationships (Vertonghen & Theeboom, 2010)—presents a distinct psychological context underrepresented in the existing evidence base (Lakes & Hoyt, 2004).

Second, existing intervention studies tend to test single techniques in isolation (Balban *et al.*, 2023; Cumming & Williams, 2013; Wendsche & Lohmann-Haislah, 2022), limiting practical utility for coaches. No published study has evaluated a rotating, multi-technique recovery toolkit delivered within actual martial arts training sessions and measured against a construct as specific as Training Fatigue. The present study addresses both gaps, providing preliminary evidence relevant to sport psychology, counseling practitioners working with athletes (Tenenbaum & Eklund, 2007; Williams & Krane, 2021), and coaching practice.

3. Methodology

A. Research Design

This study employed a single-group pre-post design. All participants received the structured psychological recovery intervention across 4 weeks of regular taekwondo training. Outcome data were collected at two time points: baseline (Week 0, before any intervention) and post-intervention assessment (Week 4, following the final intervention session).

B. Variables

Treatment (Intervention): Structured psychological recovery activities (breathwork, guided visualization, micro-breaks) delivered by the coach at the start of each training session across 4 weeks.

Outcome Variables: (1) Training Fatigue (TF), measured via the 8-item Training Fatigue Scale (TFS); (2) intrinsic training motivation, assessed via the SMS-II intrinsic motivation subscale; (3) perceived stress, measured via the PSS-10.

Control Variables: Belt level, years of experience, and training frequency, managed through inclusion criteria.

C. Operational Definitions

Training Fatigue (TF): A state of cognitive and emotional depletion arising from overexposure to repetitive training practice. Operationalized as the mean composite score of the 8-item TFS, assessing cognitive-physical fatigue (4 items) and emotional exhaustion from training (4 items). Higher TFS scores indicate greater training fatigue.

Intrinsic Motivation: The degree to which a student engages in taekwondo for inherently satisfying reasons. Measured via the intrinsic motivation subscale of the SMS-II (Pelletier *et al.*,

2013). Higher scores indicate greater self-determined engagement.

Perceived Stress: The degree to which situations are appraised as unpredictable, uncontrollable, and overloading. Measured via the PSS-10 (Cohen *et al.*, 1983). Note: the PSS-10 employs a one-month retrospective window; because baseline and post-intervention assessments are separated by 4 weeks, PSS-10 change scores will be interpreted as directional trend data rather than precise point-in-time estimates.

D. Sample Design

Participants were recruited via convenience sampling from a taekwondo academy in Bangalore, India. All adult students aged 18–26 who met inclusion criteria were invited to participate. A demographic questionnaire was administered at baseline to document age, sex, belt level, and years of training.

E. Sample Size

A target of 30 participants was set based on practical considerations. An a priori power analysis using G*Power 3.1 (two-tailed paired-samples t-test, $d = 0.50$, $\alpha = .05$, power = 0.80) indicated a minimum of 34 participants required. At $n = 30$, estimated power is approximately 0.69 (Cohen, 1988). This study is treated as exploratory and adequately powered for detecting medium-to-large effects. Findings should be interpreted accordingly, with replication in larger samples recommended.

F. Inclusion and Exclusion Criteria

Inclusion: (1) Age 18–26 years; (2) Actively enrolled in taekwondo for ≥ 3 months; (3) Attending at least 3 sessions per week; (4) Written informed consent obtained; (5) Adequate English literacy.

Exclusion: (1) Acute injury preventing safe training participation; (2) Diagnosed psychological or medical conditions interfering with study tasks.

G. Instruments

Training Fatigue Scale (TFS): An 8-item scale developed for this study to operationalize TF. Items were adapted from established fatigue and emotional exhaustion constructs (Maslach & Jackson, 1981; Raedeker, 1997; Van Cutsem *et al.*, 2017). Four items assess cognitive-physical fatigue; four assess emotional exhaustion from training. Responses use a 5-point Likert scale (1 = Never; 5 = Always). The TF score is the mean of all 8 items (range 1–5). As the TFS is a newly developed instrument, Cronbach's α was computed as an initial internal consistency check (DeVellis, 2016; Nunnally, 1978).

Perceived Stress Scale (PSS-10): A 10-item validated measure of perceived stress in the past month (Cohen *et al.*, 1983; Cohen & Williamson, 1988). Scores range 0–40; higher scores indicate greater stress ($\alpha = .78-.91$).

Sport Motivation Scale-II (SMS-II): An 18-item validated scale assessing intrinsic motivation, extrinsic motivation, and amotivation in sport (Pelletier *et al.*, 2013; Vallerand *et al.*, 1992). The intrinsic motivation subscale (items 1–3; range 1–7) is the primary outcome ($\alpha = .80-.87$). The SMS-II extends and refines earlier work on sport motivation regulation (Lonsdale *et al.*, 2008) within an SDT framework (Deci & Ryan, 1985, 2008).

H. Intervention Protocol

Each training session began with a 3–5-minute structured recovery activity delivered by the coach before any physical warm-up. Activities rotated across four weeks as shown in Table 1. Coaches received a one-hour pre-study briefing and written session-by-session delivery scripts. Fidelity was supported by the standardized script; independent auditing was not conducted.

I. Procedure

Pre-Baseline (minimum 3 days before Week 0): Participant information sheets distributed. Written informed consent obtained.

Baseline (Week 0): Administer demographic questionnaire, PSS-10, SMS-II, and TFS. Coach briefed.

Intervention Phase (Weeks 1–4): Coach delivers the scheduled 3–5-minute recovery activity at the start of each session per protocol.

Post-Intervention Assessment (Week 4, final session): Re-administer PSS-10, SMS-II, and TFS. Brief group debrief.

J. Data Analysis Plan

All analyses were conducted using Python (SciPy 1.11). Shapiro-Wilk tests assessed normality of change score distributions. Normally distributed change scores were analyzed with paired-samples t-tests; non-normal distributions with Wilcoxon signed-rank tests. Effect sizes were computed as Cohen's d (matched-pairs formula: mean difference divided by SD of differences; Cohen, 1988). Spearman's ρ was used for the correlational analysis given non-normal change score distributions. The significance threshold was $\alpha = .05$ (two-tailed) for all tests.

K. Ethical Considerations

1. Written informed consent obtained from all participants at least 3 days before baseline data collection.
2. Voluntary participation; participants may withdraw at any time without consequence.
3. Participants identified only by anonymous ID codes; data stored securely and reported in aggregate.
4. All activities non-invasive and carry minimal psychological risk.

Table 1
Four-week intervention protocol

Week	Activity	Technique	Duration
1	Breathwork	Box breathing — equal 4-count inhale, hold, exhale, hold (4-4-4-4), repeated 4–5 times	3-5 min
2	Guided Visualization	Coach-led imagery: visualize executing a confident and precise poomsae form from start to finish	3-5 min
3	Micro-breaks	Passive quiet rest with eyes closed; full cognitive disengagement	3-5 min
4	Rotation	Sessions cycle in fixed order: breathwork → visualization → micro-break	3-5 min

Note: Week 4 rotation follows a fixed sequence to preserve treatment integrity

5. Group debrief conducted at the post-intervention assessment session.

4. Results

A. Overview

This chapter presents findings from statistical analyses conducted to address the two primary hypotheses, the secondary outcome, and the correlational research question. The total sample comprised 30 adult taekwondo students (23 male, 7 female; $M = 22.27$ years, $SD = 2.49$, range = 18–26 years). All tests were two-tailed with $\alpha = .05$.

B. Preliminary Analyses

1) Descriptive Statistics

Table 2

Descriptive statistics for all outcome variables at baseline and post-intervention

Variable	n	M	SD	Min	Max	Skew	Kurt
<i>Perceived Stress (PSS-10)</i>							
Week 0	30	23.50	7.44	5.00	35.00	-0.38	-0.35
Week 4	30	22.70	7.27	12.00	36.00	0.30	-1.00
<i>Intrinsic Motivation (SMS-II)</i>							
Week 0	30	5.53	0.70	3.33	6.67	-1.01	1.78
Week 4	30	5.79	0.83	4.00	7.00	-0.32	-0.43
<i>Training Fatigue (TFS)</i>							
Week 0	30	3.05	0.89	1.62	5.00	0.15	-0.91
Week 4	30	3.20	0.87	1.38	4.38	-0.68	-0.72

Note: PSS-10 range = 0–40 (higher = more stress). SMS-II intrinsic motivation range = 1–7 (higher = more motivation). TFS range = 1–5 (higher = more fatigue). Skew = skewness; Kurt = excess kurtosis.

Table 2 presents means, standard deviations, minimum and maximum values, skewness, and kurtosis for all outcome variables. At baseline, perceived stress scores were elevated ($M = 23.50$, $SD = 7.44$), consistent with moderate-to-high stress (Cohen et al., 1983). Intrinsic motivation was moderately high at baseline ($M = 5.53$, $SD = 0.70$ on a 1–7 scale). TFS scores were in the moderate range ($M = 3.05$, $SD = 0.89$ on a 1–5 scale).

2) Normality Testing

Table 3 presents Shapiro-Wilk results for change score distributions. TFS change scores were normally distributed, $W = 0.955$, $p = .236$, supporting a parametric paired-samples t-test for H1. Intrinsic motivation change scores, $W = 0.866$, $p = .001$, and PSS-10 change scores, $W = 0.803$, $p < .001$, departed significantly from normality. Accordingly, Wilcoxon signed-rank tests were used for H2 and the secondary PSS-10 outcome.

Table 3

Shapiro-Wilk normality test results for change score distributions

Change Score Variable	W	p	Normal?	Test Selected
TFS	0.955	0.236	Yes	Paired t-test
SMS-II	0.866	0.001	No	Wilcoxon signed rank
PSS-10	0.803	<0.001	No	Wilcoxon signed rank

Note: Normality assessed at $\alpha = .05$ (two-tailed). Change scores = Week 4 minus Week 0

Table 4

Summary of inferential test results

Outcome	W0 M (SD)	W4 M (SD)	Statistic	p	d	
Training Fatigue ^a	3.05 (0.89)	3.20 (0.87)	t(29) = 1.03	.313	0.19	ns
Intrinsic Motivation ^b	5.53 (0.70)	5.79 (0.83)	W=64	.023	0.44	*
Perceived Stress ^b	23.50 (7.44)	22.70 (7.27)	W=51	.007	0.37	*

Note. ^a Paired-samples t-test. ^b Wilcoxon signed-rank test. Cohen's $d = \text{mean difference} / \text{SD of differences}$. Spearman ρ (ΔTFS , ΔIM) = -0.204 , $p = .280$. * $p < .05$; ns = non-significant.

3) Internal Consistency of the TFS

The TFS demonstrated acceptable internal consistency at baseline ($\alpha = .80$) and post-intervention ($\alpha = .78$), meeting the conventional $\alpha \geq .70$ threshold for new instruments (Nunnally, 1978; DeVellis, 2016).

C. Hypothesis 1: Training Fatigue

H1 predicted significantly lower TFS scores at post-intervention. Contrary to prediction, mean TFS scores showed a small, non-significant increase from baseline ($M = 3.05$, $SD = 0.89$) to post-intervention ($M = 3.20$, $SD = 0.87$), mean difference = $+0.15$ ($SD = 0.82$, $SE = 0.15$), 95% CI $[-0.15, 0.46]$, $t(29) = 1.03$, $p = .313$, $d = 0.19$. The effect size was negligible, and the direction of change was opposite to the hypothesized direction. H1 was not supported.

D. Hypothesis 2: Intrinsic Motivation

H2 predicted significantly higher intrinsic motivation at post-intervention. Intrinsic motivation increased significantly from baseline ($M = 5.53$, $SD = 0.70$) to post-intervention ($M = 5.79$, $SD = 0.83$), $W = 64.00$, $p = .023$, $d = 0.44$. The effect size was in the small-to-medium range. Of the 30 participants, 19 showed an increase in intrinsic motivation, 4 showed a decrease, and 7 showed no change. H2 was supported.

E. Secondary Outcome: Perceived Stress

Perceived stress decreased significantly from baseline ($M = 23.50$, $SD = 7.44$) to post-intervention ($M = 22.70$, $SD = 7.27$), $W = 51.00$, $p = .007$, $d = 0.37$. The effect size was small. Given the PSS-10's one-month retrospective window and the 4-week study duration, the measurement windows overlap substantially. PSS-10 change scores should be interpreted as directional trend data rather than precise pre-post estimates.

F. Correlational Analysis

Spearman's ρ revealed a weak, non-significant negative correlation between ΔTFS and ΔIM , $\rho = -0.204$, $p = .280$. While the direction was negative and consistent with theoretical prediction, the effect was too weak and statistically unreliable to support meaningful interpretation.

G. Summary of Results

Table 4 presents a consolidated summary of all inferential test results. H1 was not supported; H2 was supported. The secondary PSS-10 outcome also reached significance. The correlational analysis yielded a weak, non-significant result.

5. Discussion

A. Overview

This section interprets findings from section 4 in light of the theoretical frameworks and literature outlined in section 1 and 2. The intervention was associated with a statistically significant increase in intrinsic motivation (H2 supported) and a significant reduction in perceived stress (secondary outcome), but did not produce a significant change in training fatigue (H1 not supported). The correlation between changes in fatigue and motivation yielded a weak, non-significant negative relationship.

B. Hypothesis 1: Training Fatigue Did Not Decrease

The finding that Training Fatigue did not decrease and indeed showed a small, non-significant increase from Week 0 ($M = 3.05$) to Week 4 ($M = 3.20$), $t(29) = 1.03$, $p = .313$, $d = 0.19$ was contrary to H1. Several explanations may account for this outcome.

1) Minimum Effective Dose and Duration

The most parsimonious explanation is that the intervention dose a single 3–5 minute activity per session over 4 weeks was insufficient to produce a detectable change in training fatigue. Wendsche and Lohmann-Haislah (2022) found that micro-break effects were strongest when breaks occurred within rather than before effortful tasks. The present study placed recovery activities at session onset, which may have maximized motivational priming while limiting capacity to interrupt the fatigue accumulation occurring during training. Kenttä and Hassmén (1998) distinguish between acute within-session recovery and longer-term psychological restoration, arguing the latter requires sustained exposure across weeks or months. A 3–5 minute pre-session activity may prime motivational states but fall below the threshold required to reduce a construct as robust as training fatigue.

2) Increasing Training Demands

Training demands at the academy may have increased during the intervention period—for instance, due to belt grading preparation or increased session intensity. If training loads rose concurrently with the intervention, any fatigue-reducing effects may have been offset by elevated exertion demands. Future studies should incorporate session Rating of Perceived Exertion (RPE) measures to account for training load variation (Foster *et al.*, 2001; Halson, 2014).

3) TFS Psychometric Limitations

The TFS is a purpose-built instrument administered for the first time. Although it demonstrated acceptable internal consistency ($\alpha = .80, .78$), its construct validity and sensitivity to change are untested. It may lack the specificity to detect subtle within-session fatigue fluctuations that brief interventions realistically produce. Development of a psychometrically rigorous TFS is identified as a research priority (DeVellis, 2016; Nunnally, 1978).

4) Fatigue as a Slowly Changing Construct

From a psychobiological perspective (Marcora *et al.*, 2009), training fatigue reflects the cumulative subjective experience of sustained effort across sessions—a slower-changing construct than momentary motivational states. Van Cutsem *et al.* (2017)

noted that fatigue impairs performance primarily through its effect on effort allocation, a mechanism that may require sustained intervention over longer periods to reverse meaningfully. Longer exposure periods of 8–12 weeks may be required (Martin *et al.*, 2018; Pageaux & Lepers, 2018).

C. Hypothesis 2: Intrinsic Motivation Increased Significantly

The significant increase in intrinsic motivation from Week 0 ($M = 5.53$) to Week 4 ($M = 5.79$), $W = 64.00$, $p = .023$, $d = 0.44$, provides support for H2 and represents the most substantive positive finding. The small-to-medium effect size indicates a practically meaningful improvement in self-determined training engagement.

1) Self-Determination Theory Account

From an SDT perspective (Ryan & Deci, 2000), the improvement is consistent with the prediction that autonomy-supportive conditions enhance self-determined engagement. By providing students with structured self-regulation tools, the intervention reinforced perceived competence and autonomy within a highly prescriptive training environment. Ntoumanis (2001) demonstrated that perceived autonomy support in PE settings significantly predicted intrinsic motivation, and Pelletier *et al.* (2001) showed that autonomy support predicted sustained participation over time. These findings are consistent with the present motivational gains (Deci *et al.*, 1999; Standage *et al.*, 2003).

2) Contribution of Imagery and Breathwork

The guided visualization component likely contributed specifically to motivation gains. Cumming and Williams (2013) argued that mastery imagery of personal competence and enjoyment is among the most potent drivers of intrinsic engagement (Martin *et al.*, 1999; Morris *et al.*, 2005). The Week 2 script directed participants to imagine confident poomsae execution, aligning directly with mastery imagery. Slimani *et al.* (2016) found guided imagery consistently associated with improved confidence and focus in taekwondo athletes. The breathwork component may have contributed by reducing pre-session sympathetic arousal and priming autonomous engagement; Balban *et al.* (2023) showed breathwork effects on mood emerging within the first week of practice.

3) Motivation as a Faster-Responding Construct

The dissociation between motivation gains and fatigue null results suggests that motivation and fatigue respond to brief interventions on different timescales (Edmunds *et al.*, 2008). Motivation, as an attitudinal and affective construct, may shift relatively rapidly in response to positive training experiences. Training fatigue, as a cumulative psychobiological process (Marcora *et al.*, 2009; Van Cutsem *et al.*, 2023), requires longer and more intensive intervention to reverse. This implies that brief psychological recovery activities are better characterized as motivational primers than as fatigue-reduction tools within short intervention windows.

D. Secondary Outcome: Perceived Stress Decreased

The significant reduction in PSS-10 scores from Week 0 ($M = 23.50$) to Week 4 ($M = 22.70$), $W = 51.00$, $p = .007$, $d = 0.37$, is a secondary positive finding. Baseline scores fell in the moderate-to-high stress range (Cohen *et al.*, 1983), consistent

with stressors associated with regular martial arts training and early adulthood. The reduction aligns with evidence that breathwork and mindfulness-based techniques reduce stress even when practised briefly (Balban *et al.*, 2023; Ma *et al.*, 2017; Zaccaro *et al.*, 2018). The micro-break condition may have contributed through cognitive disengagement, which Wendsche and Lohmann-Haislah (2022) identified as the key predictor of micro-break effectiveness for stress reduction. This finding should be interpreted cautiously given the PSS-10's overlapping retrospective measurement windows (see Chapter 3).

E. Correlational Analysis

The non-significant Spearman correlation ($\rho = -0.204$, $p = .280$) between changes in training fatigue and motivation is most parsimoniously explained by the null result for H1. Since training fatigue did not change significantly at the group level, TFS change scores were characterized by considerable variability around zero ($M = +0.15$, $SD = 0.82$), limiting the statistical opportunity for a meaningful correlation to emerge. Future studies in which fatigue is successfully reduced may be better positioned to detect this theoretically predicted association.

F. Theoretical Contributions

First, the study introduces Training Fatigue as a conceptual construct differentiating monotony-driven psychological depletion from overtraining syndrome (Kreher & Schwartz, 2012; Meeusen *et al.*, 2013), competition anxiety, or general life stress (Lazarus & Folkman, 1984). Existing burnout frameworks describe emotional exhaustion as a component of broader burnout trajectories (Maslach & Jackson, 1981; Raedeke, 1997; Smith, 1986), but TF provides a more targeted, actionable framework for coaches and practitioners (Goodger *et al.*, 2007; Lemyre *et al.*, 2008).

Second, this study advances ecological validity by embedding a rotating multi-technique toolkit within real taekwondo training. Most prior work tests single techniques in controlled settings (Balban *et al.*, 2023; Cumming & Williams, 2013; Wendsche & Lohmann-Haislah, 2022). Demonstrating that coach-delivered rotating interventions produce measurable motivational outcomes strengthens the translational value of these techniques.

Third, the dissociation between motivation and fatigue outcomes contributes to the literature on differential response timescales in sport psychology interventions, with implications for intervention design, parameter selection, and outcome prioritization (Hardy *et al.*, 1996; Tenenbaum & Eklund, 2007).

G. Practical Implications

The significant improvement in intrinsic motivation suggests that brief, coach-delivered recovery activities are a viable and low-cost tool for enhancing motivational engagement. Given that intrinsic motivation is a robust predictor of sustained sport participation (Pelletier *et al.*, 2001; Weiss & Williams, 2004), even small-to-medium improvements over 4 weeks could have meaningful long-term implications for athlete retention. Coaches do not require specialist training to deliver the

intervention.

The stress reduction finding, while secondary and methodologically caveated, supports embedding brief breathwork or rest activities into routine training as a low-barrier strategy for stress management (Gustafsson *et al.*, 2007; Lemyre *et al.*, 2008). For counseling psychologists working with athletes, these findings underscore the value of brief PST-based self-regulation interventions (Williams & Krane, 2021) in preventive grassroots sport settings where access to dedicated sport psychologists is limited (Moran & Toner, 2017; Weinberg & Gould, 2019).

H. Summary

The central theoretical insight emerging from this study is the dissociation between motivation and fatigue as outcomes of brief psychological recovery interventions. Intrinsic motivation responded meaningfully to the 4-week intervention; training fatigue did not. This pattern suggests differential response timescales, with important implications for intervention design. The significant motivational and stress findings provide a meaningful evidence base for recommending the integration of brief psychological recovery activities into taekwondo and similar sport training environments.

6. Limitations

This study acknowledges several methodological limitations that should be considered when interpreting findings.

- Single-group pre-post design: Without a control group, observed changes cannot be attributed exclusively to the intervention. Improvements may reflect natural maturation, Hawthorne effects, or regression to the mean. Future research should employ waitlist-control or randomized designs to establish causal inference.
- Small sample and reduced statistical power: A target of $n = 30$ provides approximately 0.69 power for detecting a medium effect ($d = 0.50$), below the conventional 0.80 threshold. The study is best treated as an exploratory investigation providing effect size estimates for future controlled trials (Cohen, 1988).
- Newly developed TFS instrument: The TFS has not undergone external validation, test-retest reliability testing, or confirmatory factor analysis. Cronbach's α from this study provides an initial internal consistency estimate, but findings should be interpreted cautiously until independent validation is completed (DeVellis, 2016; Nunnally, 1978).
- PSS-10 retrospective window: The PSS-10 assesses stress over the past month. With baseline and post-intervention assessments separated by exactly 4 weeks, measurement windows overlap almost entirely. PSS-10 change scores reflect a partially overlapping period and should be treated as directional trend data.
- Short observation window: A 4-week period limits conclusions about durability of effects. Longitudinal follow-up would be required to assess whether gains are maintained beyond the intervention period

(Kellmann, 2010; Kellmann *et al.*, 2018).

- Convenience sampling: Participants were drawn from a single academy in Bangalore and may not represent young adult taekwondo practitioners more broadly.
- Coach-delivered fidelity: Coach adherence to protocol was not independently audited, introducing potential treatment inconsistency.
- Rotation design: Because activities rotate across weeks, the study cannot determine which technique—breathwork, visualization, or micro-breaks—drives observed effects. Dismantling designs would be required for technique-specific efficacy (Hardy *et al.*, 1996).

Taken together, these limitations establish the study as a preliminary investigation that generates hypotheses and provides effect size estimates for future controlled trials, rather than a study that establishes definitive causal conclusions.

7. Conclusion

A. Overview of the Study

This dissertation examined the effects of a 4-week structured psychological recovery intervention on Training Fatigue, intrinsic motivation, and perceived stress among 30 adult taekwondo students (aged 18–26; $M = 22.27$, $SD = 2.49$) from an academy in Bangalore, India. The intervention comprised box breathing, guided poomsae visualization, and passive micro-breaks delivered by the coach at the start of each training session. Outcome data were collected at baseline (Week 0) and post-intervention (Week 4) using the TFS, SMS-II, and PSS-10.

B. Summary of Findings

The study produced a mixed pattern of results. H1 was not supported: TFS scores showed a small, non-significant increase from baseline ($M = 3.05$) to post-intervention ($M = 3.20$), $t(29) = 1.03$, $p = .313$, $d = 0.19$. H2 was supported: intrinsic motivation increased significantly from Week 0 ($M = 5.53$) to Week 4 ($M = 5.79$), $W = 64.00$, $p = .023$, $d = 0.44$. The secondary outcome (PSS-10) improved significantly, decreasing from Week 0 ($M = 23.50$) to Week 4 ($M = 22.70$), $W = 51.00$, $p = .007$, $d = 0.37$, though this finding should be interpreted cautiously given overlapping PSS-10 measurement windows. The correlation between changes in training fatigue and intrinsic motivation was weak and non-significant, $\rho = -0.204$, $p = .280$.

C. Interpretation and Significance

The central theoretical insight emerging from this study is the dissociation between motivation and fatigue as outcomes of brief psychological recovery interventions. Intrinsic motivation responded meaningfully to the 4-week intervention, while training fatigue did not. This suggests that motivation and fatigue operate on different response timescales, with important implications for intervention design. The null result for H1 is not merely negative: it delineates what brief, pre-session micro-interventions can and cannot achieve within a 4-week window, helping practitioners set realistic expectations about the scope

and dose of brief psychological recovery tools.

D. Contributions of the Study

First, the study introduces Training Fatigue as a conceptual construct differentiating monotony-driven depletion from overtraining syndrome (Kreher & Schwartz, 2012), burnout (Raedeke & Smith, 2001; Smith, 1986), or general stress (Lazarus & Folkman, 1984). The TFS, with acceptable initial internal consistency ($\alpha = .80, .78$), provides a foundation for further validation. Second, the study advances ecological validity by embedding a rotating multi-technique toolkit within real training sessions, demonstrating that coach-delivered recovery activities produce measurable psychological outcomes. Third, the study extends SDT (Ryan & Deci, 2000; Ryan & Deci, 2017) into the specific context of martial arts training, providing preliminary evidence that brief autonomy-supportive activities enhance intrinsic motivation in authority-structured sport environments.

E. Future Research Directions

Future studies should test longer intervention periods (8–12 weeks) to determine whether fatigue reduction requires greater exposure. Waitlist-control or cluster-randomized designs are needed to establish causal inference. The TFS requires confirmatory factor analysis, test-retest reliability testing, and concurrent validity studies against established instruments (DeVellis, 2016). Studies should incorporate session RPE measures to control for training load variation (Foster *et al.*, 2001; Halson, 2014). Replication across other repetitive-training sports including gymnastics, swimming, and other martial arts disciplines would determine generalizability.

F. Closing Statement

This study set out to address a gap at the intersection of sport psychology, counseling psychology, and martial arts training: the absence of empirically tested, coach-deliverable strategies for managing the psychological costs of repetitive practice. The results indicate that a 4-week intervention combining breathwork, guided visualization, and micro-breaks can produce meaningful improvements in intrinsic motivation and perceived stress among adult taekwondo students, even when administered in a minimal dose by coaches without specialist training. While training fatigue was not significantly reduced, this null result enriches our understanding of the differential timescales on which motivational and fatigue constructs respond to brief psychological interventions. The findings affirm that integrating structured psychological recovery into everyday martial arts coaching is feasible, acceptable, and associated with at least some of the intended benefits—one practice session at a time.

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