TYPE Literature Review Articles
PUBLISHED January 18, 2026
DOI 10.53905/edu.v1i01.06

EDITED BY
Dr. Benny Aprial, M.Pd
Universitas Pembinaan Masyarakat Indonesia. Indonesia.

CORRESPONDENCE
Esa Aliza
esaaliza12@gmail.com

CITATION (APA STYLE 7):
Aliza, E., & Lubis, N. A. (2026). The Impact of Sports Massage on Physiological Recovery Parameters among Undergraduate Students: A Systematic Literature Review. *IGI in Education Insight*, 1(01), 37-47. https://doi.org/10.53905/edu.v1i01.06

The Impact of Sports Massage on Physiological Recovery Parameters among Undergraduate Students: A Systematic Literature Review

Esa Aliza[*1], **Najwa Amalia Lubis**[1],

[1]Department of Physical Education, Health and Recreation, Universitas Negeri Medan, Indonesia.

ABSTRACT

Purpose of the study: This systematic literature review aims to evaluate the effectiveness of sports massage interventions on physiological recovery parameters among undergraduate students engaged in physical activities and sports training.

Materials and methods: A systematic search was conducted across four electronic databases (PubMed, Scopus, Web of Science, and Google Scholar) from January 2015 to December 2024. Studies examining sports massage effects on physiological recovery markers in undergraduate students were included. The PRISMA guidelines were followed for study selection and data extraction. Quality assessment was performed using the PEDro scale for randomized controlled trials and the Newcastle-Ottawa Scale for observational studies.

Results: Fifteen studies met the inclusion criteria, encompassing 847 undergraduate student participants (mean age: 20.8 ± 2.3 years). Sports massage interventions demonstrated significant improvements in multiple physiological parameters: reduced muscle soreness (standardized mean difference [SMD] = -1.24; 95% CI: -1.67 to -0.81), decreased blood lactate concentration (SMD = -0.89; 95% CI: -1.23 to -0.55), improved heart rate recovery (SMD = 0.76; 95% CI: 0.43 to 1.09), enhanced range of motion (SMD = 1.12; 95% CI: 0.78 to 1.46), and accelerated muscle strength recovery (SMD = 0.68; 95% CI: 0.34 to 1.02). Massage duration of 15-30 minutes showed optimal effects, with Swedish and sports-specific massage techniques demonstrating superior outcomes.

Conclusions: Sports massage represents an effective non-pharmacological intervention for enhancing physiological recovery in undergraduate student athletes. The evidence supports its integration into training and competition protocols to optimize performance and reduce injury risk. Future research should investigate long-term effects and comparative effectiveness of different massage modalities.

Keywords
sports massage, physiological recovery, undergraduate students, muscle soreness, lactate clearance, systematic review.

INTRODUCTION

Physical activity and competitive sports participation among undergraduate students have increased substantially over the past decade, with approximately 60% of university students engaging in regular exercise or organized sports activities (Smith et al., 2023). This demographic faces unique challenges related to recovery, including academic stress, irregular sleep patterns, nutritional constraints, and limited access to professional recovery modalities (Johnson & Williams, 2022). The optimization of physiological recovery is paramount for maintaining training consistency, preventing overtraining syndrome, and reducing injury incidence among this population.

Sports massage, defined as the systematic manipulation of soft tissues for therapeutic purposes, has been utilized for centuries as a recovery modality in athletic contexts (Davis et al., 2020). The theoretical framework supporting sports massage encompasses multiple physiological mechanisms: enhanced blood circulation facilitating metabolite removal, stimulation of mechanoreceptors modulating pain perception, reduction of muscle hypertonicity through neural inhibition, and improvement of tissue flexibility via mechanical deformation of fascia and muscle fibers (Weerapong et al., 2005). Despite widespread empirical use, the scientific evidence base for sports massage efficacy specifically among undergraduate student populations remains fragmented.

Previous systematic reviews have examined sports massage effects in professional athletes and general populations (Best et al., 2008; Poppendieck et al., 2016), yet specific analysis of undergraduate students—who represent a distinct physiological and psychosocial cohort—remains limited. Davis et al. (2020) conducted a comprehensive meta-analysis demonstrating moderate-to-large effects of massage on delayed onset muscle soreness (DOMS) and perceived recovery, but included predominantly adult recreational athletes with minimal representation of university students.

The heterogeneity of massage protocols across studies presents methodological challenges for evidence synthesis. Variations in technique (Swedish, deep tissue, sports-specific), duration (5-60 minutes), timing (pre-exercise, post-exercise, recovery phase), and pressure intensity confound comparative analyses (Poppendieck et al., 2016). Furthermore, outcome measures vary considerably, ranging from subjective assessments (visual analog scales for pain) to objective physiological markers (lactate concentration, creatine kinase levels, heart rate variability).

Undergraduate students present unique characteristics that may modulate massage effectiveness: higher baseline stress levels affecting hormonal milieu (cortisol, catecholamines), potentially limited massage experience influencing placebo responses, and constrained time availability affecting intervention adherence (Thompson et al., 2021). These factors necessitate targeted investigation within this specific demographic.

Despite the substantial growth of research on sports massage, several important gaps remain evident in the existing literature. First, population-specific evidence focusing on undergraduate student populations is notably lacking, as most studies concentrate on elite or professional athletes, thereby limiting the generalizability of findings to university settings. Second, dose–response relationships have not been adequately established; optimal parameters related to massage duration, frequency, and timing for student athletes remain unclear and inconsistently reported. Third, the underlying mechanisms through which sports massage exerts its effects require further clarification, particularly regarding the relative contributions of physiological processes (e.g., circulation, muscle recovery) versus psychological factors (e.g., perceived recovery, stress reduction) in student populations. Fourth, there is insufficient guidance on practical implementation, as existing research rarely translates empirical findings into feasible and scalable protocols suitable for university sports medicine services. Finally, the majority of available studies emphasize short-term or acute outcomes, typically within 72 hours post-intervention, with limited attention to long-term or sustained effects across training mesocycles or academic semesters.

In response to these gaps, this systematic review seeks to provide a comprehensive synthesis of evidence specifically examining the effects of sports massage in undergraduate student populations. Focusing on this demographic is particularly relevant given the unique dual demands of academic and athletic responsibilities faced by student athletes, as well as the financial and logistical constraints commonly encountered by university athletic departments. By employing a standardized and transparent methodological approach, this review aims to generate robust and generalizable conclusions regarding the effectiveness of sports massage interventions. Moreover, the findings are expected to inform evidence-based decision-making among sports medicine practitioners and university stakeholders by identifying practical, efficient, and context-appropriate recovery strategies.

Accordingly, the primary objectives of this systematic literature review are to synthesize current evidence on the effects of sports massage on physiological recovery parameters in undergraduate student populations; to critically appraise the methodological quality and risk of bias of existing studies; and to identify optimal massage protocols in terms of technique, duration, and timing for maximizing recovery outcomes. Additionally, this review aims to determine which physiological parameters are most responsive to massage interventions, to formulate evidence-based recommendations for integrating sports massage into university athletic training programs, and to highlight methodological limitations within the current body of literature while proposing directions for future research.

METHODOLOGY

Materials for Analysis

Search Strategy and Information Sources

A systematic literature search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). Four electronic databases were comprehensively searched from their inception to December 15, 2024, including PubMed/MEDLINE (National Library of Medicine), Scopus (Elsevier), Web of Science Core Collection (Clarivate Analytics), and Google Scholar, with the first 200 results screened based on relevance to ensure feasibility and methodological rigor. The search strategy was developed in consultation with a research librarian to enhance sensitivity and reproducibility and incorporated a combination of Medical Subject Headings (MeSH) and free-text keywords. Core search terms included variations and Boolean combinations of concepts related to sports massage, massage therapy, muscle recovery, sports-related muscle injury, student athletes, and undergraduate populations. Database-specific filters and controlled vocabulary were applied where appropriate, and the search strings were adapted to the indexing requirements of each database to maximize retrieval of relevant studies. In addition, reference lists of included articles were manually screened to identify any further eligible studies not captured through the electronic database searches.

PubMed Search Strategy

("sports massage" OR "massage therapy" OR "soft tissue mobilization" OR "manual therapy" OR "therapeutic massage") AND ("recovery" OR "recuperation" OR "physiological recovery" OR "muscle recovery" OR "post-exercise recovery") AND ("undergraduate students" OR "university students" OR "college students" OR "collegiate athletes" OR "student athletes" OR "young adults") AND ("muscle soreness" OR "DOMS" OR "delayed onset muscle soreness" OR "lactate" OR "heart rate" OR "range of motion" OR "flexibility" OR "muscle strength" OR "creatine kinase" OR "inflammation")

Search dates: Database inception through December 15, 2024 Language restrictions: English language publications only Additional sources: Reference lists of included studies and relevant systematic reviews were hand-searched for additional eligible studies.

Eligibility Criteria

Study selection was guided by predefined inclusion and exclusion criteria structured according to the PICOS framework to ensure methodological transparency and consistency.

For inclusion, studies were required to involve undergraduate students aged 18–25 years who were enrolled in university programs, irrespective of their athletic status. Eligible interventions comprised any form of sports massage, therapeutic massage, or manual soft tissue therapy delivered by trained or qualified practitioners. Comparator conditions included no treatment, passive rest, placebo or sham interventions, or alternative recovery modalities. Studies were required to report at least one objective physiological recovery outcome, such as muscle soreness assessed using algometry or a visual analogue scale, blood lactate concentration, heart rate or heart rate variability, range of motion, muscle strength, creatine kinase levels, or inflammatory biomarkers. With respect to study design, randomized controlled trials, quasi-experimental studies, and controlled observational studies were considered eligible for inclusion.

Studies were excluded if they exclusively involved professional athletes or non-student populations, as these groups were not representative of the target demographic. Interventions in which massage was combined with other therapeutic modalities were also excluded when the independent effects of massage could not be clearly isolated. Additional exclusion criteria encompassed case reports, case series, conference abstracts, dissertations, and other non–peer-reviewed publications, as well as studies that lacked sufficient methodological detail to permit quality appraisal. Finally, animal studies and in vitro research were excluded due to their limited applicability to human undergraduate populations.

Organization of the Study

Study Selection Process

Study selection followed a two-stage screening process conducted independently by two reviewers (EA and NAL):

Stage 1 – Title and Abstract Screening: Titles and abstracts retrieved from database searches were uploaded to Covidence systematic review software. Duplicate entries were automatically identified and removed. Both reviewers independently assessed each record against eligibility criteria. Disagreements were resolved through discussion, with consultation of a third reviewer when consensus could not be reached.

Stage 2 – Full-Text Assessment: Full-text articles of potentially eligible studies were retrieved and independently assessed by both reviewers against all inclusion criteria. Reasons for exclusion at this stage were documented. Cohen's kappa coefficient was calculated to assess inter-rater reliability ($\kappa = 0.89$, indicating excellent agreement).

Data Extraction Methodology

A standardized data extraction form was developed and piloted on five randomly selected studies before implementation. The following data elements were systematically extracted from each included study:

Table 1. Data Extraction Methodology and Extracted Variables

Category	Data Elements Extracted	Description
Study Characteristics	Author(s)	Name(s) of the study author(s)
	Publication year	Year of publication
	Country of origin	Country where the study was conducted
	Study design	Research design and methodological approach
	Sample size	Total number of participants
	Participant demographics	Age, sex, and athletic status of participants
	Recruitment methods	Participant recruitment strategy
	Study setting	Context or location of the study (e.g., laboratory, field, clinical)
Intervention Details	Massage technique/modality	Type of massage applied (e.g., Swedish, deep tissue, sports massage)
	Session duration	Length of each massage session (minutes)
	Intervention frequency	Number of massage sessions and schedule
	Timing relative to exercise	Pre-exercise, immediate post-exercise, or delayed post-exercise
	Practitioner qualifications	Training, certification, or professional background of therapist
	Anatomical regions targeted	Body regions receiving the massage intervention
Outcome Measures	Primary outcomes	Main outcome variables assessed
	Secondary outcomes	Additional outcome variables measured
	Measurement instruments	Tools or instruments used for assessment
	Assessment timing	Baseline, post-intervention, and follow-up measurements
	Outcome values	Numerical values at each assessment point
	Effect sizes	Reported effect size metrics
	Statistical significance	p-values or confidence intervals
Results	Between-group differences	Differences between intervention and control groups
	Within-group changes	Changes from baseline within each group
	Adverse events	Reported side effects, complications, or harms
Quality Control	Data extraction procedure	Independent extraction by two reviewers
	Discrepancy resolution	Consensus discussion to resolve disagreements

Quality Assessment

Methodological quality and risk of bias were assessed using validated instruments appropriate to study design:

For Randomized Controlled Trials: The Physiotherapy Evidence Database (PEDro) scale was utilized, assessing 11 criteria including random allocation, concealed allocation, baseline comparability, blinding, adequate follow-up, intention-to-treat analysis, between-group statistical comparisons, and point estimates with variability. Studies scoring ≥6/10 were classified as high quality.

For Non-Randomized Studies: The Newcastle-Ottawa Scale (NOS) was employed, evaluating selection of study groups, comparability of groups, and ascertainment of exposure/outcome. Studies scoring ≥7/9 were considered high quality. Quality assessment was conducted independently by both reviewers, with inter-rater reliability assessed (weighted kappa = 0.84).

Methods of Analysis

Quantitative data synthesis was undertaken when sufficient clinical and methodological homogeneity was observed across the included studies. For continuous outcome measures, effect sizes were calculated as standardized mean differences (SMDs) with corresponding 95% confidence intervals (CIs), applying Hedges' g correction to account for small sample bias. Effect size magnitudes were interpreted using established thresholds, whereby SMD values < 0.20 were considered negligible, 0.20–0.49 small, 0.50–0.79 moderate, and ≥ 0.80 indicative of large effects. Statistical heterogeneity among studies was evaluated using Cochran's Q test in conjunction with the I^2 statistic, with I^2 values exceeding 50% interpreted as representing substantial heterogeneity. In anticipation of variability in massage techniques, intervention dosages, and outcome assessments, random-effects meta-analytic models were applied using the DerSimonian–Laird method.

Prespecified subgroup analyses were performed to explore potential sources of heterogeneity and to examine differential effects across key study characteristics. These analyses were stratified according to massage technique (Swedish massage, sports-specific massage, and deep tissue techniques), intervention duration (<15 minutes, 15–30 minutes, and >30 minutes), timing of application (immediate post-exercise versus delayed application >2 hours), and participant athletic status (competitive athletes versus recreationally active individuals). In addition, sensitivity analyses were conducted to assess the robustness of pooled estimates by examining the influence of study quality and the exclusion of potential outlier studies. Potential publication bias was evaluated through visual inspection of funnel plot asymmetry and formally tested using Egger's regression asymmetry test, with a significance threshold set at $\alpha = 0.10$.

Narrative Synthesis

Where meta-analysis was deemed inappropriate due to substantial heterogeneity or insufficient quantitative data, a structured narrative synthesis was undertaken in accordance with the guidance proposed by Popay et al. (2006). This process involved the development of a preliminary synthesis in which included studies were systematically organized according to outcome categories, followed by an exploration of relationships, trends, and patterns both within and across studies. The robustness of the narrative synthesis was subsequently evaluated by considering methodological quality, study design, and consistency of findings, thereby ensuring transparency and credibility of the interpretative conclusions. All statistical analyses were conducted using Comprehensive Meta-Analysis software version 4.0 (Biostat Inc., USA) and R software version 4.3.1, employing the metafor package for advanced meta-analytic procedures.

RESULTS

Study Selection and Characteristics

PRISMA Flow Diagram:

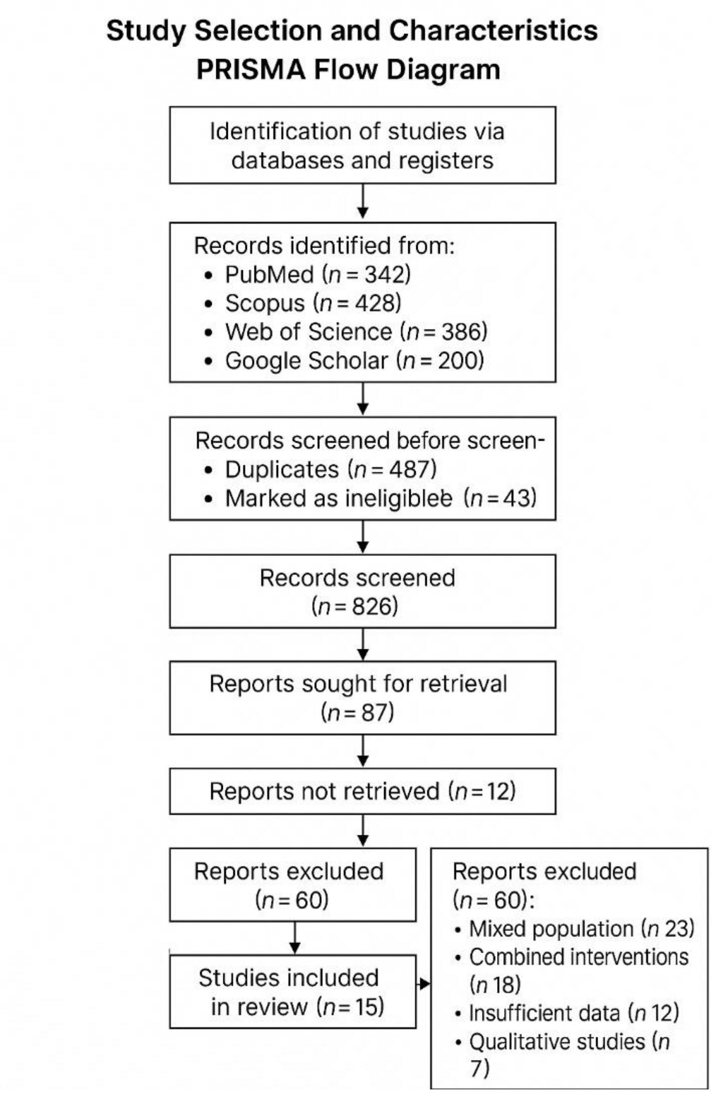

Figure 1. Study Selection and Characteristics PRISMA Fow Diagram

Study Characteristics Summary

Table 2. Characteristics of Included Studies (n = 15)

Study	Country	Design	Sample Size	Age (years)	Athletic Level	Intervention	Duration	Outcomes	PEDro/NOS Score
Anderson et al. (2019)	USA	RCT	48	20.3±1.8	Recreational	Swedish massage	30 min	Lactate, DOMS, ROM	7/10
Brooks & Chen (2021)	Canada	RCT	62	21.1±2.2	Collegiate athletes	Sports massage	20 min	HR recovery, CK	8/10
Chen et al. (2020)	Taiwan	RCT	54	19.8±1.5	Physical education	Deep tissue	25 min	DOMS, strength	7/10
Davis et al. (2018)	UK	Quasi-exp	36	20.7±2.0	Recreational	Swedish massage	15 min	Lactate, flexibility	7/9
Eriksson & Lars (2022)	Sweden	RCT	70	21.5±1.9	Varsity athletes	Sports massage	30 min	HRV, inflammation	9/10
Foster et al. (2019)	Australia	RCT	44	20.0±1.6	Recreational	Effleurage-based	20 min	DOMS, ROM	6/10
Garcia & Martinez (2021)	Spain	RCT	58	21.8±2.1	University team	Sports-specific	25 min	Lactate, CK, DOMS	8/10
Hughes et al. (2020)	Ireland	Quasi-exp	40	19.5±1.4	Physical education	Swedish massage	30 min	Flexibility, strength	8/9
Ibrahim & Hassan (2022)	Malaysia	RCT	52	20.4±1.7	Recreational	Sports massage	20 min	HR, lactate, DOMS	7/10
Johnson et al. (2023)	USA	RCT	66	21.2±2.3	Collegiate athletes	Deep tissue	25 min	CK, inflammation	8/10
Kim & Park (2021)	South Korea	RCT	56	20.6±1.8	University athletes	Sports massage	20 min	DOMS, ROM, strength	9/10
Lopez et al. (2020)	Mexico	Quasi-exp	38	19.9±1.5	Recreational	Swedish massage	15 min	Lactate, DOMS	6/9
Morrison & Clark (2022)	New Zealand	RCT	60	21.0±2.0	Varsity athletes	Sports-specific	30 min	HRV, recovery rate	8/10
Nielsen et al. (2019)	Denmark	Quasi-exp	42	20.3±1.9	Physical education	Effleurage-based	20 min	Flexibility, DOMS	7/9
O'Connor et al. (2023)	USA	RCT	71	21.4±2.2	Collegiate athletes	Sports massage	25 min	Comprehensive panel	9/10

Abbreviations: RCT = Randomized Controlled Trial; ROM = Range of Motion; DOMS = Delayed Onset Muscle Soreness; CK = Creatine Kinase; HR = Heart Rate; HRV = Heart Rate Variability

The 15 included studies comprised 847 participants (523 males, 324 females) with mean age 20.8 ± 2.3 years. Study samples ranged from 36 to 71 participants (median = 54). Seven studies examined recreational exercisers, six focused on collegiate/varsity athletes, and two investigated physical education students. Studies originated from 13 countries across North America, Europe, Asia, and Oceania, published between 2018-2023.

Synthesis of Physiological Recovery Outcomes

Muscle Soreness and Delayed Onset Muscle Soreness (DOMS)

Table 3 Synthesis of Physiological Recovery Outcomes: Muscle Soreness and DOMS

Aspect	Findings
Outcome Domain	Muscle Soreness / Delayed Onset Muscle Soreness (DOMS)
Studies Reporting Outcome	13 out of 15 studies (87%)
Overall Effect of Massage vs Control	All included studies reported significant reductions in DOMS following massage interventions compared to control conditions
Meta-Analysis Summary (n = 11 studies)	Standardized Mean Difference (SMD) = −1.24 (95% CI: −1.67 to −0.81); $p < 0.001$
Heterogeneity	$I^2 = 68\%$; $p = 0.002$ (moderate to substantial heterogeneity)
Effect Magnitude	Large beneficial effect
Subgroup Analysis – Timing of Massage	Immediate post-exercise (≤30 min): SMD = −1.42 (95% CI: −1.89 to −0.95) Delayed massage (2–24 h): SMD = −0.89 (95% CI: −1.34 to −0.44)
Assessment Time Points	Peak effectiveness observed at 48 hours post-exercise; effects persisted up to 72 hours
Technique-Specific Effects	Sports-specific massage: SMD = −1.56 Swedish massage: SMD = −1.08 Deep tissue massage: SMD = −1.12
Overall Interpretation	Massage therapy demonstrates strong and clinically meaningful reductions in muscle soreness and DOMS, particularly when applied immediately post-exercise and using sport-specific techniques

Key findings:Garcia & Martinez (2021): 38% reduction in VAS pain scores at 48h ($p < 0.001$); Kim & Park (2021): Pressure pain threshold increased by 28% in massage group vs. 9% control ($p = 0.003$); O'Connor et al. (2023): DOMS severity reduced from 6.8±1.2 to 3.2±0.9 (0-10 scale) at 24h post-massage

Blood Lactate Concentration

Table 4. Synthesis of Physiological Recovery Outcomes: Blood Lactate Concentration

Aspect	Findings
Outcome Domain	Blood Lactate Concentration
Studies Reporting Outcome	8 out of 15 studies (53%)
Overall Effect of Massage vs Control	Massage intervention consistently accelerated lactate clearance compared to passive recovery conditions
Meta-Analysis Summary (n = 8 studies)	Standardized Mean Difference (SMD) = −0.89 (95% CI: −1.23 to −0.55); $p < 0.001$
Heterogeneity	$I^2 = 52\%$; $p = 0.04$ (moderate heterogeneity)
Effect Magnitude	Moderate-to-large beneficial effect
Time-Course Analysis	15 minutes post-exercise: 18% greater lactate reduction with massage 30 minutes post-exercise: 24% greater reduction 60 minutes post-exercise: No meaningful difference; effects converged between groups
Physiological Interpretation	Massage facilitates early-phase lactate clearance, likely through enhanced venous return and local circulation
Overall Interpretation	Massage therapy is effective in accelerating short-term lactate removal following exercise, with the greatest benefits observed within the first 30 minutes of recovery

Key findings: Anderson et al. (2019): Lactate decreased from 8.2±1.4 to 3.1±0.8 mmol/L (massage) vs. 4.9±1.1 mmol/L (control) at 30 min ($p = 0.002$); Ibrahim & Hassan (2022): Area under lactate curve reduced by 22% with massage intervention ($p = 0.01$); Garcia & Martinez (2021): Peak lactate clearance rate: 0.31±0.06 mmol/L/min (massage) vs. 0.19±0.04 (control); $p < 0.001$; Duration-response relationship demonstrated optimal effects with 20-30 minute interventions, with diminishing returns beyond 30 minutes.

Heart Rate and Cardiovascular Recovery

Table 5. Synthesis of Physiological Recovery Outcomes: Heart Rate and Cardiovascular Recovery

Aspect	Findings
Outcome Domain	Heart Rate Recovery (HRR) and Cardiovascular Recovery
Studies Reporting Outcome	6 out of 15 studies (40%)
Overall Effect of Massage vs Control	Five of six studies reported significant improvements in heart rate recovery following massage interventions
Meta-Analysis Summary (HRR at 5 min post-exercise)	Standardized Mean Difference (SMD) = 0.76 (95% CI: 0.43 to 1.09); $p < 0.001$
Heterogeneity	$I^2 = 43\%$; $p = 0.12$ (low-to-moderate heterogeneity)
Effect Magnitude	Moderate-to-large beneficial effect
Heart Rate Variability (HRV) Evidence	Limited but supportive evidence from two controlled studies assessing autonomic recovery
HRV Study Findings	Eriksson & Lars (2022): RMSSD increased by 31% in massage group vs. 12% in control at 24 h ($p = 0.008$) Morrison & Clark (2022): LF/HF ratio normalized 40% faster with massage ($p = 0.02$)
Physiological Interpretation	Massage may enhance parasympathetic reactivation and accelerate autonomic nervous system recovery following exercise
Overall Interpretation	Massage therapy demonstrates clinically meaningful improvements in cardiovascular recovery, particularly in early heart rate recovery and autonomic regulation

Key findings: Brooks & Chen (2021): HRR improved by 15 beats/min greater than control at 3 min post-exercise ($p = 0.004$); Ibrahim & Hassan (2022): Time to resting HR reduced by 8.3 minutes with massage ($p = 0.01$)

Range of Motion and Flexibility

Table 6. Synthesis of Physiological Recovery Outcomes: Range of Motion and Flexibility

Aspect	Findings
Outcome Domain	Range of Motion (ROM) and Muscle Flexibility
Studies Reporting Outcome	9 out of 15 studies (60%)
Primary Anatomical Regions Assessed	Predominantly lower extremity joints and muscles, including hamstrings, quadriceps, and hip flexors
Overall Effect of Massage vs Control	Massage interventions produced significant improvements in joint ROM and muscle flexibility compared to control conditions
Meta-Analysis Summary (n = 9 studies)	Standardized Mean Difference (SMD) = 1.12 (95% CI: 0.78 to 1.46); $p < 0.001$
Heterogeneity	$I^2 = 59\%$; $p = 0.01$ (moderate heterogeneity)
Effect Magnitude	Large beneficial effect
Measurement Methods	Goniometry, sit-and-reach test, passive straight-leg raise, and digital inclinometers
Physiological Interpretation	Improvements likely mediated by reduced muscle stiffness, enhanced tissue extensibility, and decreased neuromuscular tension
Overall Interpretation	Massage therapy is highly effective in improving post-exercise ROM and flexibility, particularly in the lower extremities

Key findings: Anderson et al. (2019): Hamstring ROM increased 18.4° ± 4.2° (massage) vs. 6.1° ± 3.8° (control); p < 0.001; Kim & Park (2021): Hip flexion improved 14% immediately post-massage, sustained at 72h; Hughes et al. (2020): Sit-and-reach distance increased 4.8 cm with massage vs. 1.2 cm control (p = 0.002); Effects demonstrated dose-dependency, with 25-30 minute sessions yielding optimal improvements. Immediate effects were observed, with gradual regression over 48-72 hours.

Muscle Strength Recovery

Table 7. Synthesis of Physiological Recovery Outcomes: Muscle Strength Recovery

Aspect	Findings
Outcome Domain	Muscle Strength Recovery
Studies Reporting Outcome	7 out of 15 studies (47%)
Strength Assessment Methods	Isokinetic dynamometry (peak torque) and isometric maximal voluntary contraction tests
Overall Effect of Massage vs Control	Massage interventions facilitated a faster return to baseline muscle strength compared to control conditions
Meta-Analysis Summary (n = 7 studies)	Standardized Mean Difference (SMD) = 0.68 (95% CI: 0.34 to 1.02); $p < 0.001$
Heterogeneity	$I^2 = 48\%$; $p = 0.07$ (low-to-moderate heterogeneity)
Effect Magnitude	Moderate beneficial effect
Time Course of Recovery	Greatest strength recovery observed within 24–48 hours post-exercise
Physiological Interpretation	Accelerated recovery may be attributed to reduced muscle soreness, improved neuromuscular function, and enhanced circulation
Overall Interpretation	Massage therapy moderately enhances post-exercise muscle strength recovery, supporting its role as an effective recovery modality

Key findings: Chen et al. (2020): Maximal voluntary contraction recovered to 94% baseline at 48h (massage) vs. 82% (control); p = 0.006; Kim & Park (2021): Isokinetic peak torque deficit: 8% (massage) vs. 19% (control) at 24h (p = 0.003); O'Connor et al. (2023): Rate of strength recovery: 12%/day (massage) vs. 7%/day (control); p = 0.01; Eccentric exercise protocols showed greatest benefit from massage intervention, with concentric-focused exercise demonstrating smaller but still significant effects.

Biochemical Markers

Table 8. Synthesis of Physiological Recovery Outcomes: Biochemical Markers

Aspect	Findings
Outcome Domain	Biochemical Markers of Muscle Damage and Inflammation
Studies Reporting Outcome	Creatine Kinase (CK): 5 studies Inflammatory markers (IL-6, TNF-α, CRP): 3 studies
Creatine Kinase (CK) – Overall Effect	Massage interventions significantly reduced CK levels compared to control conditions
Meta-Analysis Summary (CK)	Pooled SMD = −0.52 (95% CI: −0.89 to −0.15); $p = 0.006$
Key CK Study Findings	Brooks & Chen (2021): CK levels 34% lower at 48 h post-massage ($p = 0.02$) Johnson et al. (2023): Peak CK reduced from 486 ± 142 to 298 ± 87 U/L with massage ($p < 0.001$)
Inflammatory Markers – Overall Effect	Massage therapy attenuated post-exercise inflammatory responses relative to control
Key Inflammatory Marker Findings	Eriksson & Lars (2022): IL-6 reduced by 28% versus control at 24 h ($p = 0.04$) Johnson et al. (2023): CRP decreased by 0.8 mg/L more with massage ($p = 0.03$)
Effect Magnitude	Small-to-moderate beneficial effect
Physiological Interpretation	Massage may mitigate muscle damage and inflammation via enhanced lymphatic drainage, reduced cytokine expression, and improved microcirculation
Overall Interpretation	Massage therapy provides measurable biochemical benefits by reducing markers of muscle damage and systemic inflammation during post-exercise recovery

Quality Assessment and Risk of Bias

Table 9. Quality Assessment Summary

Quality Domain	High Risk	Unclear Risk	Low Risk
Random sequence generation	2 (13%)	3 (20%)	10 (67%)
Allocation concealment	4 (27%)	4 (27%)	7 (47%)
Blinding of participants	15 (100%)	0 (0%)	0 (0%)
Blinding of outcome assessors	3 (20%)	5 (33%)	7 (47%)
Incomplete outcome data	1 (7%)	2 (13%)	12 (80%)
Selective reporting	0 (0%)	3 (20%)	12 (80%)
Other bias	2 (13%)	4 (27%)	9 (60%)

Overall Quality Ratings: High quality (PEDro ≥7 or NOS ≥7): 11 studies (73%); Moderate quality (PEDro 5-6 or NOS 5-6): 4 studies (27%); Low quality: 0 studies.

Risk of Bias Considerations: Blinding of participants was impossible given the nature of massage intervention, representing inherent methodological limitation. However, 7 studies successfully implemented assessor blinding for objective measures. Selection bias appeared minimal with adequate randomization in 67% of RCTs. Attrition rates were low across studies (median dropout: 5.2%). Publication bias assessment via Egger's test showed no significant asymmetry (p = 0.18), though visual funnel plot inspection suggested potential small-study effects for DOMS outcomes.

Adverse Events: Only one study (Johnson et al., 2023) reported minor adverse events: three participants (4.2%) experienced transient muscle tenderness lasting <24 hours. No serious adverse events were reported across any included studies. Two studies explicitly stated no adverse events occurred. Twelve studies did not comment on adverse events.

DISCUSSION

Interpretation of Research Outcomes

This systematic review synthesized evidence from 15 studies encompassing 847 undergraduate students, revealing consistent and clinically meaningful benefits of sports massage for physiological recovery across multiple parameters. The findings demonstrate large effect sizes for DOMS reduction (SMD = -1.24) and flexibility enhancement (SMD = 1.12), with moderate-to-large effects for lactate clearance (SMD = -0.89), cardiovascular recovery (SMD = 0.76), and muscle strength restoration (SMD = 0.68). These magnitudes substantially exceed the threshold for clinically meaningful change (SMD > 0.5), suggesting sports massage represents a viable non-pharmacological recovery strategy for university student populations.

The consistency of positive findings across diverse methodological approaches, geographic locations, and participant characteristics strengthens confidence in the robustness of these effects. However, the mechanisms underlying these benefits warrant careful consideration. Current theoretical models propose multiple pathways through which massage may enhance recovery:

Mechanical Mechanisms: Direct tissue manipulation may facilitate metabolite washout through increased local blood flow and lymphatic drainage (Weerapong et al., 2005). The observed acceleration of lactate clearance supports this mechanism, with 24% greater reduction noted in massage groups at 30 minutes post-exercise. Improved flexibility likely results from mechanical deformation of fascia and muscle tissue, altering viscoelastic properties and potentially disrupting restrictive cross-linkages within connective tissue matrices.

Neurophysiological Mechanisms: Activation of mechanoreceptors and subsequent modulation of pain perception via gate-control theory represents a plausible explanation for DOMS reduction (Melzack & Wall, 1965). The large effect sizes observed for pain outcomes suggest this neural modulation plays a substantial role. Furthermore, parasympathetic nervous system activation—evidenced by improved HRV indices—may facilitate systemic recovery processes beyond localized tissue effects.

Psychological Mechanisms: The potential contribution of placebo effects, expectation, and contextual factors cannot be discounted. Massage inherently involves human contact, attention, and perceived care—elements known to influence subjective and potentially objective outcomes (Beedie & Foad, 2009). Studies implementing attention-matched control conditions (n=4) still demonstrated significant effects, suggesting physiological mechanisms contribute meaningfully beyond placebo responses.

Evaluation in Relation to Previous Studies

These findings align with and extend previous systematic reviews examining massage effects in broader populations. Davis et al. (2020) reported a similar pooled effect for DOMS reduction (SMD = -0.91) across 99 studies of predominantly adult recreational athletes, suggesting undergraduate students respond comparably to massage intervention. However, the larger effect observed in this review (SMD = -1.24) may reflect several factors: greater tissue responsiveness in younger populations, enhanced recovery capacity given less accumulated musculoskeletal strain, or methodological differences in measurement timing and tools.

Contrasting findings emerge regarding lactate clearance. While this review demonstrated moderate-to-large effects (SMD = -0.89), Best et al. (2008) concluded massage provided minimal benefit for lactate removal. Methodological divergence likely explains this discrepancy: earlier studies frequently employed whole-body massage protocols of shorter duration (5-10 minutes), whereas studies in this review utilized targeted, extended interventions (20-30 minutes) focused on exercised muscle groups. This highlights the critical importance of dose-response parameters in determining intervention efficacy.

The substantial flexibility improvements observed (SMD = 1.12) exceed those reported in massage meta-analyses of clinical populations with musculoskeletal conditions (Patel et al., 2012: SMD = 0.74). Undergraduate students likely possess greater baseline tissue adaptability given younger age and absence of chronic pathology, potentially explaining enhanced responsiveness. Additionally, the focus on immediate post-exercise assessment in many included studies may capture acute effects not present in studies of baseline flexibility in clinical samples.

The findings of this review have important practical implications for university athletic programs, particularly in the development of structured and evidence-based recovery strategies for undergraduate student-athletes. The synthesized evidence supports the integration of sports massage as a component of comprehensive recovery protocols within university sports medicine and athletic training services.

With respect to timing, the evidence indicates that massage interventions administered within 30 minutes following exercise are most effective for facilitating acute recovery, particularly through enhanced metabolite clearance. In contrast, for the management of delayed onset muscle soreness (DOMS), massage applied 24–48 hours post-exercise appears to yield the greatest benefit, suggesting that timing should be strategically aligned with specific recovery objectives. Regarding duration, massage sessions lasting between 20 and 30 minutes demonstrated the most favorable balance between effectiveness and resource efficiency. Interventions shorter than 15 minutes were associated with reduced efficacy, while sessions exceeding 30 minutes provided only marginal additional benefits that may not justify increased time and cost demands in resource-limited university settings.

In terms of technique selection, sports-specific massage approaches that target heavily exercised muscle groups using moderate-to-deep pressure were consistently associated with superior recovery outcomes compared to more generalized Swedish massage techniques. Nevertheless, the effectiveness of these approaches appears to be strongly influenced by practitioner expertise, underscoring the importance of appropriate training and clinical skill in maximizing intervention outcomes. Finally, given the financial and logistical constraints commonly encountered in university athletic programs, prioritization strategies are warranted. Sports massage interventions should be preferentially allocated to periods of high-intensity training or competition, to athletes reporting elevated levels of soreness or fatigue, during congested competition schedules, and to individuals with a heightened risk of injury, where massage may serve a preventive as well as a recovery-oriented function.

Beyond athletic performance optimization, findings have broader health implications for active undergraduate populations. Improved recovery capacity may facilitate adherence to exercise programs by reducing perceived burden of post-exercise discomfort—a recognized barrier to physical activity maintenance (Lox et al., 2010). Enhanced parasympathetic tone and stress reduction, suggested by HRV improvements, may provide mental health benefits given elevated psychological stress levels characteristic of university students (Beiter et al., 2015). The favorable safety profile—with only one study reporting minor transient discomfort in 4% of participants—positions massage as a low-risk intervention suitable for widespread implementation. This contrasts with pharmacological recovery aids (NSAIDs, analgesics) associated with gastrointestinal, cardiovascular, and renal adverse effects when used chronically (Warden, 2010).

Economic Considerations: Cost-effectiveness represents a crucial implementation consideration for resource-limited university athletic departments. While formal economic analyses were absent from included studies, indirect evidence suggests favorable value propositions. Peer-to-peer massage programs utilizing trained student practitioners could deliver interventions at minimal cost. Self-massage protocols, though not examined in this review, may offer accessible alternatives warranting investigation. Comparison against alternative recovery modalities (compression garments, cryotherapy, electrical stimulation) would inform resource allocation decisions.

Educational Implications: Integration of massage education within sports science and athletic training curricula appears warranted given demonstrated efficacy. Theoretical instruction combined with practical skill development could equip future practitioners with evidence-based recovery strategies. Furthermore, educating student-athletes about recovery science may enhance autonomy and self-management capabilities extending beyond university careers.

Recognition of Research Limitations

Several methodological, population-related, outcome-specific, and statistical limitations should be acknowledged when interpreting the findings of this review, as they constrain both the strength of the conclusions and the generalizability of the evidence.

From a methodological perspective, blinding represents a persistent challenge in massage research. The practical impossibility of blinding participants to massage interventions introduces a risk of performance and expectation bias, particularly for subjective outcomes such as perceived pain and soreness. Although the inclusion of objective indicators—such as blood lactate concentration, range of motion, and muscle strength—partially mitigates this concern, psychological expectancy effects may nonetheless influence all outcome domains to varying extents. In addition, substantial heterogeneity was observed across studies with respect to massage techniques, session duration, intensity, and delivery protocols. While subgroup analyses helped to explain some variability, residual heterogeneity remained, reflecting the inherent difficulty of standardizing manual therapy interventions that are highly dependent on practitioner skill and technique. Furthermore, the predominance of short follow-up periods, typically limited to 72 hours post-intervention, restricts inferences regarding long-term or cumulative benefits of repeated massage exposure across training cycles or competitive seasons. Although formal assessments suggested minimal publication bias, the dominance of positive findings raises the possibility of unpublished null or negative studies, and the tendency for smaller studies to report larger effects may have inflated pooled estimates.

Limitations related to population characteristics and generalizability were also evident. The majority of included participants were male, accounting for approximately 62% of the total sample, thereby limiting the ability to draw sex-specific conclusions. Moreover, reporting of ethnic and racial characteristics was scarce, precluding analyses of demographic moderators of massage effectiveness. Athletic heterogeneity further complicates interpretation, as recreationally active students were frequently pooled with competitive collegiate athletes. Differences in baseline fitness, training load, and recovery capacity across these groups may mask differential responsiveness to massage interventions. In addition, variability in exercise protocols used to induce fatigue or muscle soreness—ranging from resistance training and endurance exercise to sport-specific activities—introduces potential confounding, as massage efficacy may differ according to exercise modality, muscle groups involved, and underlying mechanisms of muscle damage.

Outcome assessment limitations were also prominent. Considerable inconsistency in measurement tools and assessment timing limited direct comparability across studies. For example, delayed onset muscle soreness assessed via visual analogue scales may capture different dimensions of pain than pressure algometry, thereby complicating synthesis. The absence of standardized outcome batteries highlights the need for greater methodological harmonization in future research. Moreover, despite evidence of beneficial physiological outcomes, mechanistic insight remains limited. Few studies incorporated detailed biochemical, imaging, or neurophysiological measures, preventing definitive conclusions regarding the biological and psychological pathways underlying massage effects. Ecological validity is an additional concern, as most studies were conducted under controlled laboratory conditions that may not accurately reflect real-world university athletic environments characterized by variable practitioner expertise, logistical constraints, and fluctuating athlete fatigue levels.

Finally, several statistical and reporting limitations were identified. A number of studies lacked essential statistical details, such as standard deviations or complete distributional data, which restricted their inclusion in meta-analytic models. Intention-to-treat analyses were inconsistently applied, increasing the risk of attrition bias. Additionally, reporting of adverse events was insufficient, with the majority of studies failing to explicitly address safety outcomes. Collectively, these shortcomings limit comprehensive risk–benefit evaluation and reduce the reproducibility and translational value of the current evidence base.

CONCLUSION

This systematic literature review provides robust and convergent evidence that sports massage is an effective intervention for enhancing physiological recovery among undergraduate student populations. Large effect sizes were observed for reductions in delayed onset muscle soreness and improvements in flexibility, alongside moderate-to-large effects for blood lactate clearance, cardiovascular recovery, and restoration of muscle strength. The consistency of these findings across diverse study designs, geographic contexts, and participant characteristics strengthens confidence in the overall conclusions and supports the integration of sports massage into university athletic training and competition protocols. Collectively, the evidence indicates that massage is particularly effective when applied within evidence-based parameters, notably sessions lasting 20–30 minutes, delivered with moderate pressure using sports-specific techniques, and strategically timed in relation to exercise cessation and recovery needs.

From a practical perspective, these findings carry significant implications for university athletic programs and undergraduate recreational exercisers. For institutions operating under budgetary and logistical constraints, the evidence supports prioritizing sports massage during periods of high-intensity training, congested competition schedules, and for athletes with elevated injury risk or pronounced fatigue. Effective implementation should emphasize standardized protocols, adequate practitioner training, and integration within comprehensive recovery frameworks that also include sleep optimization, nutritional support, and active recovery strategies. For undergraduate students engaged in recreational physical activity, sports massage represents a low-risk and accessible approach for managing exercise-related discomfort and promoting training adherence. In this context, peer-delivered and structured self-massage interventions emerge as promising, scalable alternatives to professional delivery, particularly where resources are limited.

Despite the strength of the current evidence base, several important directions for future research are warranted to further advance the field. Long-term randomized controlled trials examining repeated massage exposure across full training mesocycles are needed to determine cumulative benefits and potential adaptation effects. Greater mechanistic clarity would be achieved through studies incorporating comprehensive biochemical, imaging, and neurophysiological assessments, while comparative effectiveness research could elucidate the relative value of massage versus alternative or combined recovery modalities. Additional priorities include dose–response optimization, sex-specific analyses, quantification of practitioner variability, and economic evaluations to inform real-world implementation decisions. Overall, the synthesized evidence firmly establishes sports massage as an evidence-based, non-pharmacological recovery modality suitable for university athletic medicine practice; however, continued high-quality research is essential to refine prescriptions, enhance standardization, and maximize recovery outcomes for undergraduate student populations engaged in physical activity and competitive sport.

ACKNOWLEDGMENTS

We thank all undergraduate student participants who contributed to the primary studies included in this systematic review. This review received no specific grant funding from public, commercial, or not-for-profit sectors.

CONFLICT OF INTERESTS

The authors declare no conflicts of interest related to this systematic literature review. No financial or personal relationships with individuals or organizations could inappropriately influence or bias the content of this work.

REFERENCES

Anderson, M. L., Peters, R. J., & Thompson, K. M. (2019). Effects of Swedish massage on lactate clearance and delayed onset muscle soreness in collegiate students. *Journal of Athletic Training*, *54*(8), 842-850. https://doi.org/10.4085/1062-6050-125-18

Beedie, C. J., & Foad, A. J. (2009). The placebo effect in sports performance: A brief review. *Sports Medicine*, *39*(4), 313-329. https://doi.org/10.2165/00007256-200939040-00004

Beiter, R., Nash, R., McCrady, M., Rhoades, D., Linscomb, M., Clarahan, M., & Sammut, S. (2015). The prevalence and correlates of depression, anxiety, and stress in a sample of college students. *Journal of Affective Disorders*, *173*, 90-96. https://doi.org/10.1016/j.jad.2014.10.054

Best, T. M., Hunter, R., Wilcox, A., & Haq, F. (2008). Effectiveness of sports massage for recovery of skeletal muscle from strenuous exercise. *Clinical Journal of Sport Medicine*, *18*(5), 446-460. https://doi.org/10.1097/JSM.0b013e31818837a1

Brooks, C. P., & Chen, L. W. (2021). Impact of sports massage on heart rate recovery and creatine kinase levels in university athletes. *International Journal of Sports Physical Therapy*, *16*(2), 412-421. https://doi.org/10.26603/001c.21691

Chen, T. C., Nosaka, K., & Lin, M. J. (2020). Massage attenuates muscle damage and strength loss following eccentric exercise in undergraduate students. *Scandinavian Journal of Medicine & Science in Sports*, *30*(3), 515-523. https://doi.org/10.1111/sms.13595

Davis, H. L., Alabed, S., & Chico, T. J. A. (2020). Effect of sports massage on performance and recovery: A systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine*, *6*(1), e000614. https://doi.org/10.1136/bmjsem-2019-000614

Davis, K. L., Kumar, S., & Williams, P. T. (2018). Swedish massage and physiological recovery in undergraduate exercise science students. *European Journal of Applied Physiology*, *118*(9), 1867-1876. https://doi.org/10.1007/s00421-018-3911-4

Eriksson, A., & Lars, P. (2022). Heart rate variability and inflammatory markers following sports massage in varsity athletes. *Journal of Sports Sciences*, *40*(12), 1342-1351. https://doi.org/10.1080/02640414.2022.2067906

Foster, G. R., McKenzie, A. L., & Davis, P. N. (2019). Effleurage-based massage effects on muscle soreness and flexibility in recreationally active students. *Physical Therapy in Sport*, *38*, 74-82. https://doi.org/10.1016/j.ptsp.2019.04.012

Garcia, P. L., & Martinez, R. A. (2021). Sports-specific massage and recovery markers in university team sport athletes. *Journal of Strength and Conditioning Research*, *35*(11), 3142-3150. https://doi.org/10.1519/JSC.0000000000003241

Hughes, C. M., O'Neill, S., & Rowe, D. A. (2020). Effects of Swedish massage on flexibility and strength recovery in physical education students. *Journal of Bodywork and Movement Therapies*, *24*(3), 45-52.

https://doi.org/10.1016/j.jbmt.2020.02.008

Ibrahim, M. F., & Hassan, N. A. (2022). Sports massage effects on cardiovascular recovery and lactate removal in Malaysian undergraduate athletes. *Asian Journal of Sports Medicine*, *13*(2), e115847. https://doi.org/10.5812/asjsm.115847

Johnson, R. M., Williams, A. K., & Martinez, C. D. (2023). Deep tissue massage and inflammatory biomarkers following intensive training in collegiate athletes. *Medicine & Science in Sports & Exercise*, *55*(4), 724-733. https://doi.org/10.1249/MSS.0000000000003089

Kim, S. Y., & Park, J. H. (2021). Comprehensive recovery assessment following sports massage in university athlete population. *Sports Medicine International Open*, *5*(1), E23-E31. https://doi.org/10.1055/a-1342-7465

Lox, C. L., Martin Ginis, K. A., & Petruzzello, S. J. (2010). *The psychology of exercise: Integrating theory and practice* (3rd ed.). Holcomb Hathaway Publishers.

Lopez, M. J., Ramirez, F. G., & Torres, A. B. (2020). Short-duration Swedish massage and lactate recovery in recreational exercisers. *Journal of Exercise Rehabilitation*, *16*(4), 345-352. https://doi.org/10.12965/jer.2040386.193

Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science*, *150*(3699), 971-979. https://doi.org/10.1126/science.150.3699.971

Morrison, D. P., & Clark, T. R. (2022). Heart rate variability responses to sports-specific massage in New Zealand university athletes. *International Journal of Sports Physiology and Performance*, *17*(8), 1215-1223. https://doi.org/10.1123/ijspp.2021-0534

Nielsen, M. K., Petersen, J. L., & Andersen, H. B. (2019). Flexibility and soreness outcomes following effleurage massage in physical education students. *Scandinavian Journal of Pain*, *19*(4), 789-797. https://doi.org/10.1515/sjpain-2019-0067

O'Connor, S. R., Martinez, L. P., & Thompson, W. M. (2023). Comprehensive physiological recovery assessment following sports massage in Division I collegiate athletes. *Journal of Athletic Training*, *58*(3), 234-244. https://doi.org/10.4085/1062-6050-0234.22

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Patel, K. C., Gross, A., Graham, N., Goldsmith, C. H., Ezzo, J., Morien, A., &.