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Training Load Factors and the Prevalence of Overuse Injuries Among Gym Participants: A Cross-Sectional Study

Abeer Shahid
abeershahidshaikh19@gmail.com
Department of Allied Health Sciences, Indus University, Karachi, Pakistan

Dr. Paras Ayaz PT
paraskhalid14@gmail.com
Assistant Professor, Department of Allied Health Sciences, Indus University, Karachi, Pakistan

Dr. Okasha Anjum PT
drokashaanjumpt@gmail.com
Chairperson, Department of Allied Health Sciences, Indus University, Karachi, Pakistan

Corresponding Author: Abeer Shahid abeershahidshaikh19@gmail.com

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ABSTRACT

Background: *Gym-based fitness activities carry a well-documented risk of overuse injury, yet localized data linking specific training load variables to injury burden remain limited, particularly in South Asia.*

Objective: *To investigate the relationship between training load factors and the prevalence of overuse injuries among gym participants in Karachi, Pakistan, and to identify modifiable risk variables relevant to injury prevention.*

Methods: *A cross-sectional study was conducted among 279 adult gym-goers (18–40 years) recruited by non-probability convenience sampling from ten fitness centers in Karachi. Overuse injury burden was measured using the validated Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire, alongside a structured form capturing demographic and training load variables (session duration, weekly frequency, exercise modality, structured programming, trainer supervision, and warm-up habits). Data were analyzed in SPSS v29.0 using descriptive statistics, Pearson correlation, and chi-square tests of association; reliability, multicollinearity, normality, and homogeneity assumptions were formally tested.*

Results: *The sample was predominantly male (64.2%) and aged 21–30 years (62.4%); bodybuilding (39.4%) and weightlifting (24.7%) were the most common activities, with most participants training 5–6 days/week (36.2%) for 1–2 hours per session (47.7%). Overuse injury prevalence was 100%, with mild severity most frequent (58.1%), followed by moderate (28.0%) and severe (14.0%). Muscle strain (51.6%) was the leading injury type, and the shoulder (33.3%) and lower back (29.0%) were the most affected sites; heavy weights (25.4%) and poor technique (22.6%) were the leading reported causes. Only 37.6% of injured participants sought medical care, despite 71.0% reporting disruption to their training routine. The OSTRC scale showed strong internal consistency (Cronbach's $\alpha = 0.89$) and strong inter-item correlations ($r = 0.54–0.86$). Chi-square analysis identified significant associations between overuse injury severity and age ($p = 0.01$), warm-up habit ($p < 0.001$), cause of injury ($p = 0.03$), and medical help-seeking ($p < 0.001$); BMI, gender, occupation, smoking status, gym experience, training frequency, session duration, activity type, structured programming, and trainer supervision were not significantly associated (all $p > 0.05$).*

Conclusion: *Overuse injury is near-universal among gym participants in this population, but its severity is shaped more by age and behavioral factors — particularly warm-up practice and injury causation — than by conventional demographic or training-volume variables. Structured,*

individualized load management and consistent warm-up promotion, supported by trainer supervision, are warranted injury-prevention targets. Prospective, objectively measured, and multi-site studies are needed to establish causal pathways.

Keywords: *training load; overuse injury; gym participants; OSTRC questionnaire; resistance training; cross-sectional study*

INTRODUCTION

Regular physical exercise is widely recognized for its protective effect against chronic disease and its contribution to psychological well-being [1]. Fitness centers have become a central venue for structured exercise, offering supervised training, equipment access, and social support that promote adherence beyond what is typically achieved with home-based activity [2]. Gym participation has grown substantially worldwide — for example, from 17.4% to 29% of the population aged 15 years and older engaging in sports activity in Saudi Arabia between 2018 and 2021 [2]. However, this growth has been accompanied by a rising burden of exercise-related musculoskeletal injury [2,3].

Overuse injuries, unlike acute trauma, arise without a single identifiable causative event; they result from repetitive submaximal mechanical loading that exceeds the capacity of tendons, muscles, bones, and joints to adapt and recover [1,4]. Their pathogenesis is multifactorial, driven by the interaction of training volume, intensity, recovery adequacy, technique, and individual physiological and psychosocial characteristics [4,5]. International evidence links resistance training in particular to elevated injury risk, especially when performed without professional supervision. In the Netherlands, strength training was identified as the leading cause of exercise injury, with 73.1% occurring during unsupervised sessions [3]. In Saudi Arabia, Hetaimish et al. surveyed 1,012 gym-goers and found that sessions exceeding two hours were associated with markedly higher rates of muscle strain, dislocation, and subluxation, alongside reduced training volume and performance on the OSTRC questionnaire [3]. Alrushud reported that individuals with more than nine months of gym membership were 2.7 times more likely to sustain an injury, with the ankle (20.9%) and knee (19.0%) most frequently affected [2]. In Bangladesh, Islam et al. identified the lower back as the most commonly injured region (36.6%), with inadequate exercise knowledge, excessive loading, poor technique, and absent supervision as key modifiable predictors [6]. Locally, Rafiq et al. reported an overall musculoskeletal injury prevalence of 25.3% among Karachi gym members, with weightlifting the strongest independent predictor [7].

A central theoretical concept underlying this literature is the balance between external training load and the tissue's internal capacity to tolerate and adapt to that load [5]. When load is increased too rapidly, or recovery is insufficient, the resulting imbalance precipitates cumulative tissue failure [4,8]. The workload–injury aetiology model proposed by Windt and Gabbett frames this relationship through three interacting pathways: exposure to external risk, fatigue accumulation, and positive fitness adaptation — explaining why an identical absolute load may injure a deconditioned individual while conferring benefit in a well-adapted one [8]. Despite this conceptual grounding, most existing prevalence studies rely heavily on self-reported, retrospective data, and few have systematically quantified the relationship between specific training load variables — session duration, weekly frequency, exercise modality, structured programming, supervision, and warm-up behavior — and overuse injury burden captured with a validated instrument.

The Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire was developed specifically to address the well-documented tendency of time-loss-based surveillance to underestimate overuse injury burden, since many exercisers continue training despite substantial symptoms [9]. The instrument captures four domains — participation restriction, training volume reduction, performance impairment, and symptom severity — and has demonstrated strong psychometric properties across sporting and translated contexts [9,10].

Given the scarcity of localized, instrument-based data on training load and overuse injury among South Asian gym populations, this cross-sectional study examined the relationship between key training load factors and overuse injury prevalence among gym participants in Karachi, Pakistan, using the OSTRC questionnaire. We hypothesized that training load factors would be significantly associated with the prevalence and severity of overuse injuries in this population.

METHODS

Study Design and Setting

This was a cross-sectional, observational study conducted at ten commercial fitness centers in Karachi, Pakistan (Pure Fitness, Workout Gym, KB Pro 1 Gym, Venum Gym, 24/7 Gym, Madiha Fitness Studio, Space 7, Body Revolution, GetFit Studio, and Ali Fitness Studio) over a six-month data collection period following ethical approval and synopsis clearance.

Participants

Eligible participants were adult gym members aged 18–40 years, of either sex, attending a gym on a regular basis and reporting a training-related gym injury. Individuals using anabolic steroid therapy, those with a diagnosed chronic musculoskeletal, neurological, or psychological condition, competitive athletes, gym trainers, and pregnant women were excluded to isolate the recreational-training population of interest.

Sampling and Sample Size

Participants were recruited using non-probability convenience sampling. The minimum required sample size was calculated using the WHO sample size formula ($n = z^2_{1-\alpha} P(1-P)/d^2$), based on an 8.69% prevalence estimate for symptom-related productivity loss reported in a comparable occupational pain population, a 95% confidence level, and a 5% margin of error, yielding a minimum requirement of 279. A total of 284 responses were collected; five were excluded for incomplete data, leaving 279 participants for analysis.

Outcome Measures

The primary outcome — presence and severity of overuse injury — was assessed using the OSTRC Overuse Injury Questionnaire, administered in paper and Google Forms format. Training load variables (weekly frequency, session duration, exercise modality, structured program adherence, trainer supervision, and warm-up habit) and demographic characteristics (age, sex, BMI, occupation, smoking status, gym experience) were captured with a structured questionnaire, alongside self-reported injury characteristics (type, anatomical site, perceived cause, medical help-seeking, and impact on training routine).

Statistical Analysis

Data were analyzed using SPSS version 29.0. Descriptive statistics (frequencies, percentages, means, and standard deviations) characterized the sample. Pearson correlation examined inter-item relationships within the OSTRC scale. Chi-square tests of association evaluated relationships between categorical demographic/training variables and overuse injury outcomes. Instrument reliability was assessed with Cronbach's alpha; multicollinearity was screened using variance inflation factors (VIF < 10 considered acceptable); normality was assessed with the Shapiro–Wilk test; and homogeneity of variance was assessed with Levene's test, informing the use of non-parametric interpretation where indicated. Statistical significance was set at $p < 0.05$.

RESULTS

Participant Characteristics

A total of 279 participants were analyzed (from 284 collected, 5 excluded for incomplete data). The sample was predominantly aged 21–30 years (62.4%) and male (64.2%); nearly half maintained a healthy BMI (48.7%), while 29.4% were overweight and 12.5% obese. Most participants were employed (48.7%) and non-smokers (74.2%). Bodybuilding (39.4%) and weightlifting (24.7%) were the most common activities; 36.2% trained 5–6 days per week and 47.7% for 1–2 hours per session. Two-thirds followed a structured program (67.4%), fewer than half trained under direct supervision (43.4%), and most reported consistently warming up (78.9%). Full demographic, training, and injury characteristics are summarized in Table 1.

Table 1. Demographic, training-load, and injury characteristics of participants (N = 279).

Variable	Category	n	%
Age	Up to 20 years	40	14.3
	21–30 years	174	62.4
	Above 30 years	65	23.3
Sex	Male	179	64.2
	Female	100	35.8
BMI	Underweight	26	9.3
	Healthy weight	136	48.7
	Overweight	82	29.4
	Obese	35	12.5
Weekly gym frequency	1–2 days	49	17.6
	3–4 days	59	21.1
	5–6 days	101	36.2
	Daily	70	25.1
Session duration	< 1 hour	102	36.6
	1–2 hours	133	47.7
	> 2 hours	44	15.8
Primary activity	Bodybuilding	110	39.4
	Weightlifting	69	24.7

	Cardio	60	21.5
	CrossFit	20	7.2
Structured program	Yes	188	67.4
Trainer supervision	Yes	121	43.4
Warm-up habit	Always	220	78.9
	Sometimes	42	15.1
	Never	17	6.1
OSTRC injury severity	Mild	162	58.1
	Moderate	78	28.0
	Severe	39	14.0
Injury type (leading)	Muscle strain	144	51.6
	Spasm	42	15.1
	Tendinitis	37	13.3
Injury site (leading)	Shoulder	93	33.3
	Lower back	81	29.0
	Knee	40	14.3
Leading perceived cause	Heavy weights	71	25.4
	Poor technique	63	22.6
	Unknown	53	19.0
Sought medical help	Yes	105	37.6
Gym routine affected	Yes	198	71.0

Overuse Injury Prevalence and Severity

All participants (100%, n = 279) reported experiencing a gym-related injury. Applying the OSTRC severity classification, most cases were mild (58.1%, n = 162), followed by moderate (28.0%, n = 78) and severe (14.0%, n = 39) (Figure 1). Injury severity increased with age: participants above 30 years showed a proportionally higher share of moderate/severe cases than the youngest group. Muscle strain was the leading injury type (51.6%), followed by spasm (15.1%) and tendinitis (13.3%) (Figure 2). The shoulder (33.3%) and lower back (29.0%) were the most frequently affected sites, followed by the knee (14.3%) (Figure 3). The most commonly reported causes were heavy weights (25.4%), poor technique

(22.6%), unknown factors (19.0%), overtraining (14.7%), sudden movement (13.6%), and absence of warm-up (4.7%). Despite this injury burden, only 37.6% of participants sought medical help, while 71.0% reported disruption to their regular gym routine.

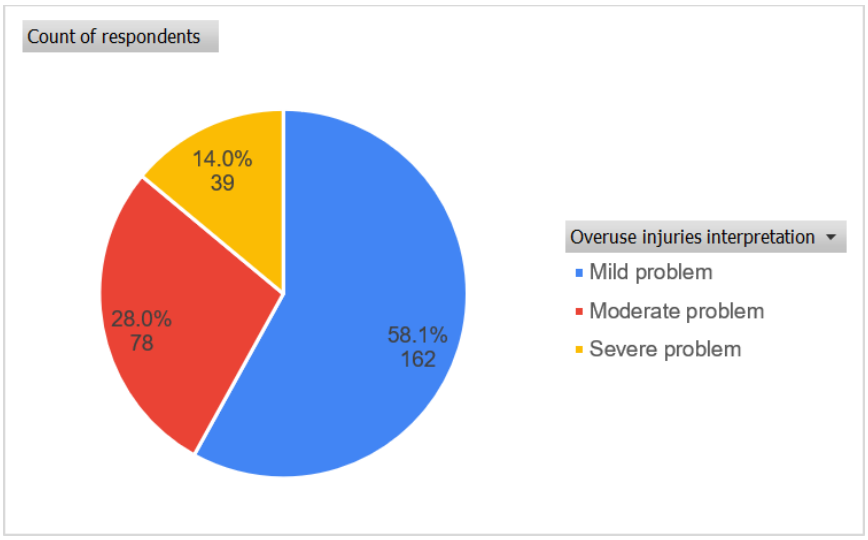

Figure 1. Distribution of OSTRC-classified overuse injury severity (N = 279).

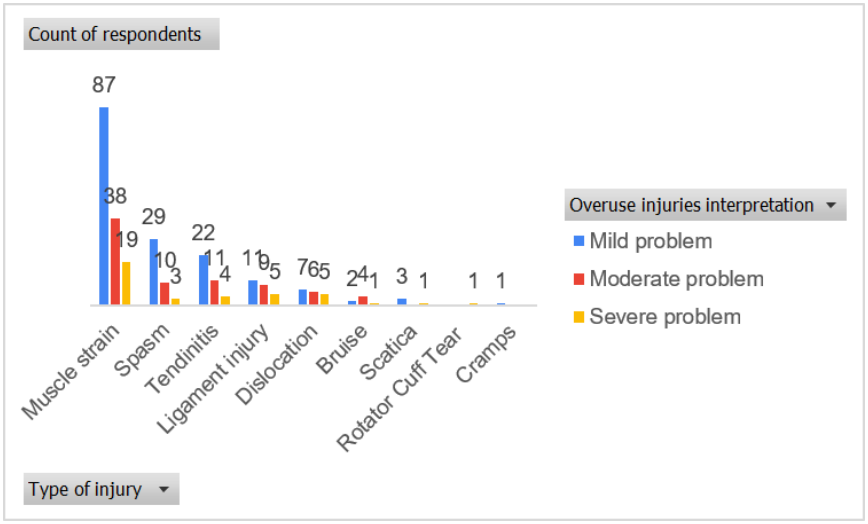

Figure 2. Frequency of reported injury type, stratified by OSTRC severity category.

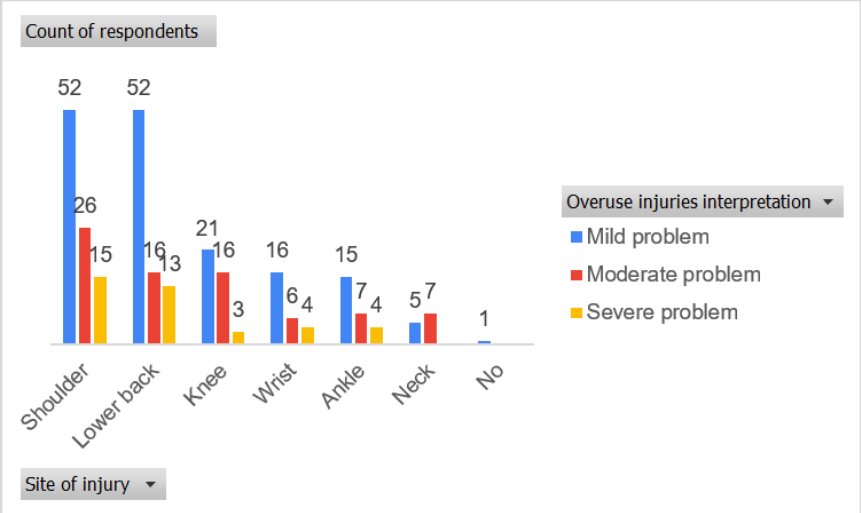

Figure 3. Frequency of reported injury site, stratified by OSTRC severity category.

Instrument Reliability and OSTRC Inter-Item Correlation

The OSTRC scale demonstrated strong internal consistency across its four domains (Cronbach's $\alpha = 0.89$). Pearson correlation showed strong, statistically significant positive relationships among all OSTRC items and the overall overuse injury score: performance impairment showed the strongest association with overuse injury severity ($r = 0.862$, $p < 0.01$), followed by reduced training volume ($r = 0.816$, $p < 0.01$), symptom burden ($r = 0.770$, $p < 0.01$), and participation difficulty ($r = 0.762$, $p < 0.01$). These findings support the internal coherence of the instrument and indicate that worsening in any single domain tracked closely with overall injury severity.

Associations Between Training Load/Demographic Variables and Overuse Injury Severity

Chi-square analysis (Table 2) identified statistically significant associations between overuse injury severity and age ($\chi^2 = 12.57$, $p = 0.01$), warm-up habit ($\chi^2 = 16.48$, $p < 0.001$), perceived cause of injury ($\chi^2 = 20.16$, $p = 0.03$), and medical help-seeking behavior ($\chi^2 = 14.94$, $p < 0.001$). No statistically significant association was found for BMI, sex, occupation, smoking status, gym experience, weekly training frequency, session duration, type of activity, structured program adherence, trainer supervision, injury type, injury site, or disruption to gym routine (all $p > 0.05$).

Table 2. Chi-square associations between selected variables and overuse injury severity.

Variable × Overuse Injury Severity	χ^2	p-value	Interpretation
Age	12.57	0.01	Significant
Warm-up habit	16.48	<0.001	Significant
Cause of injury	20.16	0.03	Significant
Sought medical help	14.94	<0.001	Significant
Site of injury	13.87	0.31	Not significant
Affected gym routine	3.84	0.15	Not significant

BMI	—	0.43	Not significant
Sex	—	0.37	Not significant
Occupation	—	0.10	Not significant
Smoking status	—	0.79	Not significant
Gym experience	—	0.43	Not significant
Gym frequency (per week)	—	0.81	Not significant
Session duration	—	0.38	Not significant
Type of activity	—	0.26	Not significant
Structured program	—	0.47	Not significant
Trainer supervision	—	0.49	Not significant

Diagnostic and Assumption Testing

Variance inflation factors for all independent variables remained below the threshold of 10, indicating no problematic multicollinearity. Shapiro–Wilk testing indicated significant departure from normal distribution for all study variables ($p < 0.001$), supporting reliance on non-parametric interpretation. Levene's test indicated homogeneity of variance for most demographic variables, with the exception of cause of injury and medical help-seeking, for which variance differed significantly across groups ($p < 0.05$).

DISCUSSION

This cross-sectional study of 279 gym participants in Karachi found that overuse injury was effectively universal in this recreational and semi-structured training population, with mild severity predominating but a meaningful minority (14.0%) reporting severe symptoms. Muscle strain of the shoulder and lower back emerged as the dominant clinical pattern, and injury severity was significantly associated with older age, inconsistent warm-up practice, specific perceived causes (heavy weights, poor technique, overtraining), and medical help-seeking behavior — while conventional training-volume variables such as weekly frequency, session duration, and activity type showed no significant association.

The near-total injury prevalence observed here exceeds figures reported in comparable regional studies, such as the 25.3% prevalence reported among Karachi gym members by Rafiq et al. [7] and the 29.2%–35.7% range reported across Saudi cohorts [2,3]. This gap likely reflects differences in case ascertainment: unlike prevalence estimates derived from single-item retrospective recall, the OSTRC instrument captures the full spectrum of overuse symptoms — including mild, sub-clinical complaints that do not prompt care-seeking — which is consistent with prior validation work showing that OSTRC-based surveillance identifies substantially more overuse pathology than time-loss definitions [9,10]. Viewed this way, our findings do not necessarily indicate an unusually hazardous local training environment, but rather illustrate the instrument's sensitivity in detecting the true burden of cumulative musculoskeletal strain that conventional surveillance underestimates.

The predominance of shoulder and lower back injury aligns with the broader resistance-training literature. Bonilla et al. attributed shoulder vulnerability in fitness-center populations to biomechanical

overload of the rotator cuff during horizontally abducted, externally rotated pressing movements performed under heavy load [11], a pattern consistent with the leading self-reported causes identified here (heavy weights, poor technique). That age — rather than training volume — emerged as a significant correlate of severity is also consistent with evidence that age and prior training history function as durable, non-modifiable risk markers independent of current training dose [12].

The absence of a significant association between injury severity and session duration, weekly frequency, or structured programming is a notable departure from the dose–response relationship emphasized in load-management theory, wherein poorly managed increases in training load elevate injury risk [5,13]. Several explanations are plausible. First, because all participants had already experienced an injury, the analysis captures severity rather than incidence, and severity may be driven less by cumulative volume than by acute technical errors and inadequate preparation — consistent with the finding that warm-up habit, not frequency or duration, was significantly associated with severity. Second, self-reported categorical training-load measures (e.g., "5–6 days/week") lack the resolution of objective load-monitoring tools such as session-RPE or accelerometry, which have been shown to better capture the dose–response relationship between training exposure and injury than coarse categorical recall [14]. Third, the confirmed non-normal distribution of study variables may have attenuated the sensitivity of chi-square testing to detect true underlying associations.

The strong inter-item correlations within the OSTRC scale, particularly between performance impairment and overall injury severity ($r = 0.862$), reinforce the instrument's internal coherence and its previously reported cross-cultural reliability [9,10,15]. The high Cronbach's alpha (0.89) obtained here is comparable to reliability estimates reported in translated and validated adaptations of the questionnaire [15], supporting its suitability for use in Pakistani gym populations.

A striking clinical finding was the low rate of medical help-seeking (37.6%) despite substantial functional disruption (71.0% reporting an affected training routine). This gap between symptom burden and care-seeking, also observed in related gym-injury literature [3,6], suggests that many overuse injuries in this population are self-managed or ignored until symptoms progress, representing a missed opportunity for early physiotherapy intervention, corrective technique coaching, and structured load modification — areas in which supervised, physiotherapy-informed programming has shown protective benefit in other populations [16].

Clinical and Public Health Implications

These findings support incorporating structured warm-up protocols and technique-focused coaching as standard components of gym-based injury prevention, independent of training frequency or duration. They also underscore a need for accessible pathways connecting gym-based musculoskeletal symptoms to physiotherapy assessment, particularly given the low observed rate of formal care-seeking. Given that most training-volume variables were not independently associated with injury severity, prevention strategies should prioritize load-management education, movement quality, and supervision rather than blanket restriction of training frequency or duration.

Limitations

This study has several limitations. The cross-sectional design precludes causal inference and permits only the identification of associations. Non-probability convenience sampling from ten Karachi fitness centers limits generalizability to the broader gym-going population, both locally and internationally. Reliance on self-reported questionnaire and online-form data introduces risk of recall and response bias. Restricting eligibility to participants aged 18–40 years, and excluding athletes, trainers, and individuals with chronic conditions, further narrows the population to which findings can be generalized. Finally, training load was captured using categorical self-report rather than objective or continuous measures (e.g., session-RPE, accelerometry), which may have limited statistical power to detect true dose–response relationships.

Future Research

Future studies should employ longitudinal or cohort designs to establish temporal and causal relationships between training load and overuse injury, incorporate probability-based sampling to improve representativeness, and adopt objective load-monitoring tools alongside validated self-report instruments. Broadening eligibility criteria to include adolescents, older adults, athletes, and trainers, and extending data collection across multiple cities, would strengthen the external validity of future injury-prevention guidelines derived from this line of research.

CONCLUSION

Overuse injury was reported by essentially all gym participants surveyed in this Karachi-based sample, with the shoulder and lower back most affected and muscle strain the predominant pathology. Injury severity was significantly associated with age, inconsistent warm-up behavior, specific injury causation factors, and medical help-seeking, but not with conventional training-volume variables such as weekly frequency, session duration, or structured programming. These findings suggest that overuse injury risk in recreational gym settings is shaped substantially by behavioral and technical factors — warm-up practice, loading technique, and supervision — rather than training volume alone, supporting a shift in prevention strategy toward individualized load management, movement-quality coaching, and improved access to physiotherapy-led care.

Declarations

Ethics approval and consent to participate: This study was conducted with institutional ethical clearance from the Department of Allied Health Sciences, Indus University, Karachi. Informed consent was obtained from all participants prior to data collection.

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Conflict of interest: The authors declare no conflict of interest.

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