Is Bouldering A Classical Overhead Sport?

Baseline Analysis of a Cohort of Brazilian Climbers

Presenter: Lucas Mena

Authors: Lucas Mena, Leonardo Zanesco, Jorge H. Assunção, Caio Checchia, Mauro Gracitelli, Eduardo A. Malavolta

Shoulder Surgery Division, Department of Orthopedics, Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil

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Disclosure:

The presenter and all authors declare that they have no conflicts of interest related to this presentation.

Data Availability: The dataset generated and analyzed during this study is publicly available on the Harvard Dataverse repository.

What is Bouldering?

Bouldering is a form of climbing on short walls or natural rock, without ropes—**crash pads** provide protection.
Originally practiced outdoors, it has evolved as an **indoor sport**, with gyms dedicated solely to bouldering.

Combines **technical** (precise) and **dynamic** (explosive) movement:

- Historically focused on **technical control**
- Past decade: shift toward **dynamic, powerful moves**
- **Recent shift**: return to technical style with **low-friction holds**

As an **Olympic discipline**, (Tokio,2020) bouldering continues to balance strength, skill, and creativity.

Introduction

Should we expect the same adaptive shoulder changes found in overhead athletes, such as GIRD?[1]

- **Bouldering** is a high-intensity climbing discipline performed without ropes, requiring explosive, overhead movements under high joint loads.
- **Despite involving overhead activity**, bouldering differs biomechanically from sports like baseball or volleyball—there is less repetition, more multidirectional effort, and no clear throwing arc.
- Previous research often treats “climbing” as a single category.[2–5]
- This study focuses specifically on **indoor bouldering**, aiming to identify injury patterns and risk factors related to **dynamic climbing movements**.

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Methods

This is a **baseline (cross-sectional) analysis** of a **cohort study** involving Brazilian indoor bouldering athletes, in São Paulo.

Recruitment:
Participants were recruited from climbing gyms in a metropolitan region between **September 2023 and May 2024**, using **convenience and snowball sampling** methods.

Inclusion Criteria:

- Age **15 to 65 years**
- At least **6 months of indoor bouldering experience**
- Regular practice: **≥2 sessions/week** or **≥10 hours/month**

Exclusion Criteria:

- Irregular climbing frequency
- Incomplete questionnaire or orthopedic evaluation

Study Workflow

1. **Online Survey**
    - Adapted [6.] and translated into Portuguese and validated for cultural relevance by local climbers
2. **In-Person Orthopedic Assessment**
    - Performed by final-year orthopedic surgery residents
    - Comprehensive physical exam of the **shoulder, elbow, wrist, and hand**[7,8]
    - **Range of motion (ROM)** measured with a goniometer
    - **Specific orthopedic tests** for instability, tendon injuries, and joint dysfunction.[8]

Methods

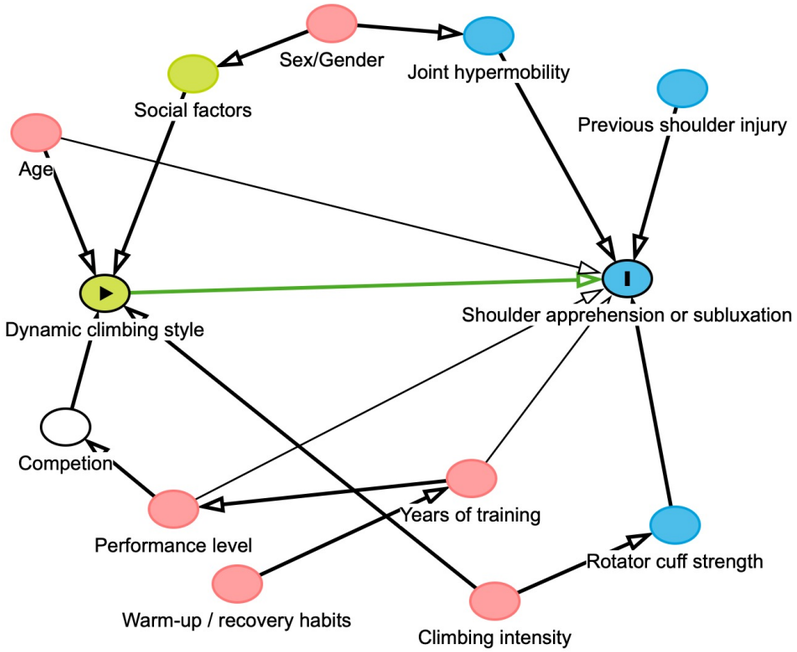
Main Variables

- **Exposures:**
  - Dynamic climbing style (**self-reported preference**)
  - Age
  - Climbing experience and training characteristics
- **Outcomes:**
  - **Pain location** (self-reported)
  - **Diagnosed injuries**
  - **Articular ROM** (dominant vs. non-dominant limbs)
  - **Findings from physical examination**

Statistical Analysis:

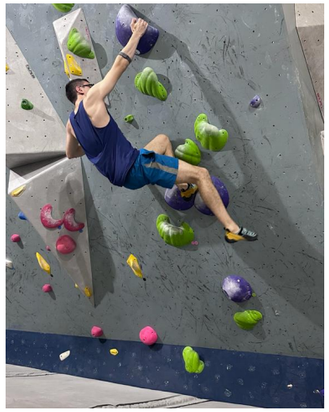
- Descriptive statistics for demographics, training, and injury rates
- Comparisons using *t-tests*, *chi-square*, and *Fisher's exact test*
- **E-value** used to estimate impact of unmeasured confounding
- Data processed using **Stata 18 (StataCorp, TX, USA)**

Directed Acyclic Graph (DAG) of Confounding and Colliding Variables in the Causal Pathway Between Dynamic Climbing Style and Shoulder Apprehension or Subluxation



Results

A total of 35 indoor bouldering athletes participated in the study, with **80% (n = 28) identifying as male**. The **mean age** was **25.9 years** (SD 8.2; range 17–60). Participants had an **average height** of **1.73 meters** (SD 0.07) and a **mean body weight** of **67 kg** (SD 9.7), resulting in a **mean BMI** of **22.2** (SD 2.3).[9,10]



Variable	Value
Sample size (n)	35
Male participants	80% (n = 28)
Age (years)	Mean = 25.9 (SD = 8.2)
Age range	17 – 60
Height (meters)	Mean = 1.73 (SD = 0.07)
Weight (kg)	Mean = 67.0 (SD = 9.7)
BMI (kg/m²)	Mean = 22.2 (SD = 2.3)

Adapted from Mena L, et al. *Prevalence and Risk Factors of Upper Extremity Injuries in Indoor Bouldering: A Cross-Sectional Study*. Cureus. 2024;16(9):e69729. DOI: 10.7759/cureus.69729

Range of motion:

Movement	Dominant Mean (°)	Non-Dominant Mean (°)	Mean Difference (°)	p-value (Wilcoxon)
Flexion	189 (SD = 2.42)	191 (SD = 2.23)	−1.83	0.34
Extension	65 (SD = 2.38)	65 (SD = 1.90)	+0.05	0.39
External Rotation	100 (SD = 2.84)	99 (SD = 2.19)	+0.94	0.74
Internal Rotation	78 (SD = 2.81)	81 (SD = 1.67)	−3.05	0.64

Movement	Apprehension Group(Mean °)	No Apprehension Group(Mean °)	p-value(Wilcoxon rank-sum)
Flexion	185	190	0.34
Extension	70	72	>0.99
Internal Rotation	69	79	0.20
External Rotation	102	99	0.69

Adapted from Mena L, et al. *Prevalence and Risk Factors of Upper Extremity Injuries in Indoor Bouldering: A Cross-Sectional Study*. Cureus. 2024;16(9):e69729. DOI: 10.7759/cureus.69729

Lesions:

Upper Limb Injuries

Finger pulley lesions were diagnosed in 22.9% of participants (n = 8; 95% CI: 11.6–40.2%).

Shoulder injuries were present in 25.7% (n = 9; 95% CI: 13.6–43.2%), including anterior shoulder apprehension in 17.1% (n = 6; CI reported elsewhere in full article).

Lateral epicondylitis was observed in 14.3% (n = 5; 95% CI: 5.9–30.8%).

Wrist ligament injuries were diagnosed in 8.6% (n = 3; 95% CI: 2.7–24.2%).

Lower Limb Injuries

Knee injuries affected 8.6% (n = 3; 95% CI: 2.7–24.2%)

Sprained ankles occurred in 5.7% (n = 2; 95% CI: 1.4–21.0%)

PREVALENCE BY LESION SITE IN CLIMBERS

Anatomical Region	Common Diagnoses	Prevalence (%)
Hand/Fingers	Finger pulley lesion	22,9
Shoulder	Anterior shoulder apprehension, rotator cuff symptoms, AC joint pain	25,7
Elbow	Lateral epicondylitis	14,3
Wrist	Ligament injuries	8,6
Knee	Sprain, trauma	8,6
Ankle/Foot	Sprained ankle landing injuries	5,7
Spine	Lumbar pain	2,9

Dynamic movement:

Climbers **who preferred dynamic movements showed** a significantly **higher prevalence** of anterior shoulder apprehension (p = 0.028) .

Prevalence Difference (Additive Scale): 30% (95% CI. 4 to 57) difference between dynamic and non-dynamic climbers.

Prevalence Ratio (Multiplicative Scale): 7.5% (95% CI 0.98 to 57.55) times the prevalence between dynamic and non-dynamic climbers.

The E-value was 14.9, meaning: An unmeasured confounder would need to be associated with both dynamic climbing and shoulder instability with a prevalence ratio **of at least 14.9** to explain away the observed effect.

Biomechanical Considerations and Clinical Relevance

No significant differences in shoulder range of motion (ROM) were found between the **dominant and non-dominant arms** across all measured movements (flexion, extension, internal rotation, external rotation) in the full cohort of climbers.

When comparing climbers **with** and **without shoulder apprehension**, **no statistically significant differences** were observed in the ROM of the affected shoulder.

Internal rotation was **on average lower** in the apprehension group (69° vs. 79°), but this difference was **not statistically significant** (*p = 0.20*), and **did not meet the threshold** for Glenohumeral Internal Rotation Deficit (GIRD).

These findings suggest that **shoulder instability in bouldering athletes** may occur **without the adaptive ROM changes** typically seen in overhead athletes, such as throwers.

Conclusion

Indoor bouldering carries a notable risk of upper extremity injuries, with the shoulder and hand most frequently affected.

This study identifies dynamic climbing movements as a significant—and importantly, modifiable—risk factor for anterior shoulder instability.

In contrast to traditional overhead athletes, climbers did not exhibit glenohumeral internal rotation deficit (GIRD) or range of motion asymmetries, pointing to a unique biomechanical pathway underlying these injuries.

Next steps

Long-Term Follow-Up:

The first participants have now reached over one year of follow-up. Data collection for the 12-month outcomes is currently underway, allowing for analysis of injury progression and recovery over time.

Expansion of the Cohort:

As this is a **dynamic cohort**, additional climbers continue to be enrolled, enhancing the study's power and generalizability.

Ultrasound in Climbing Settings:

The feasibility and utility of **point-of-care ultrasound (POCUS)** for shoulder assessment in the climbing environment is being actively evaluated, offering a promising tool for real-time injury detection and monitoring.

Point-of-care ultrasound (POCUS) assessment of the shoulder performed in a climbing gym setting as part of the field evaluation protocol.

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GRUPO DE OMBRO E COTOVELO
INSTITUTO DE ORTOPEDIA E TRAUMATOLOGIA
FACULDADE DE MEDICINA DA UNIVERSIDADE DE SÃO PAULO

Instituto de Ortopedia e Traumatologia
HCFMUSP