ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

Accounting for the Clustering Effect in Orthopaedic Surgical Randomized Controlled Trials: A Systematic Review

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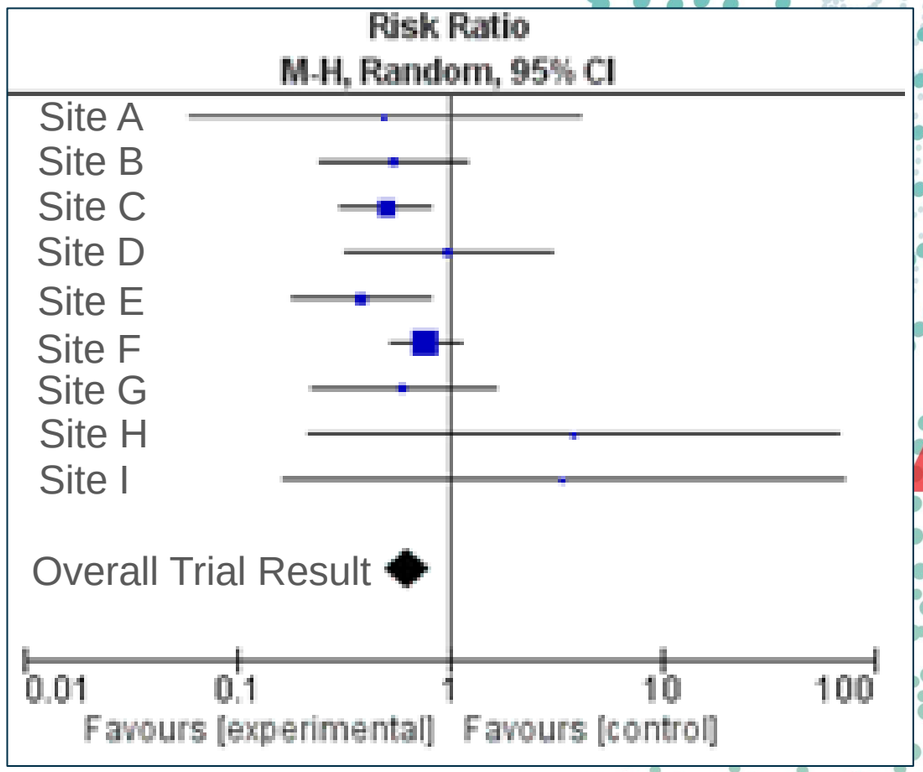
Faculty Disclosure Information

The authors have no relevant conflicts of interest to disclose.

Background

- Patients treated by the same surgeon often have similar outcomes due to shared technique, experience, and environment – known as the **clustering effect.**[1-6]
- Clustering can occur at the surgeon, center, or surgeon-within-center level.
- Failure to account for clustering can:
  - Bias treatment effect estimates
  - Underestimate standard error
  - Increase risk of Type I error



Background cont.

- Methods to control for clustering in an RCT:
    - Inflate the sample size to account for within-cluster dependency
    - Stratify randomization by surgeon and center
    - Include surgeon or surgeon nested within center as a random effect in analysis of multi-center trials

Purpose

This review examined the proportion of RCTs in the top five orthopaedic journals over the past five years that account for clustering effects in their study design and analysis.

Methods

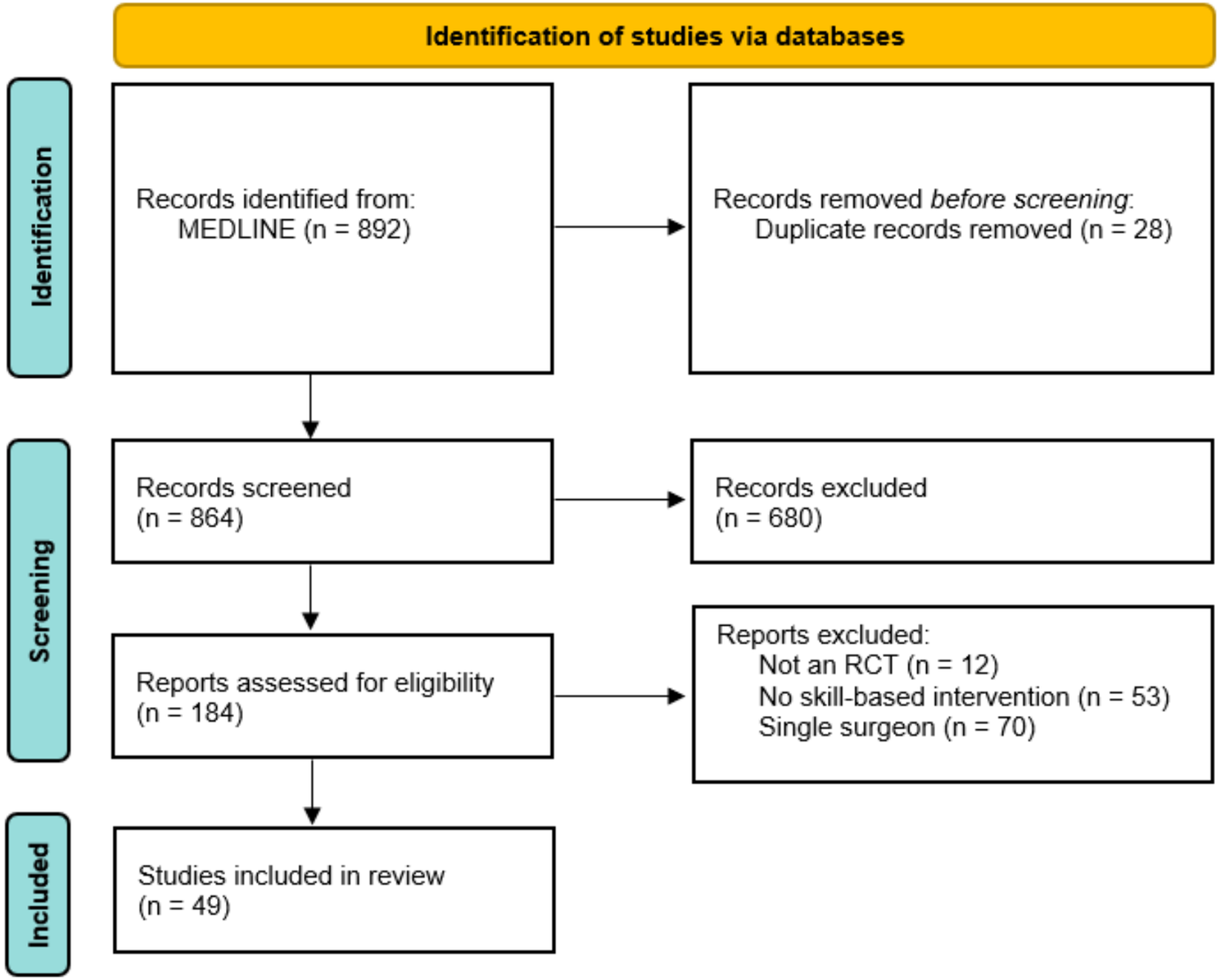
- Systematic electronic search of top five orthopaedic journals, ranked by Web of Science impact factor.
  - The American Journal of Sports Medicine
  - The Journal of Bone and Joint Surgery
  - The Journal of Arthroplasty
  - Arthroscopy: The Journal of Arthroscopic and Related Surgery
  - Clinical Orthopaedics and Related Research

Inclusion Criteria	Exclusion Criteria
RCT	Protocols
Living human subjects	
Published in English	
Included a skill-based intervention (e.g., surgery, PT)	
Multiple centers or multiple physicians	

Methods

- What counts as a study that accounted for clustering effects?
  - Specifically described surgeon-level clustering effects, including;
    - Intraclass correlation coefficient,
    - variance inflation factor, or
    - design effect
  - Stratified randomization by surgeon and center
  - Used a mixed/random-effects model with surgeon as a random effect or explicitly stated that surgeon-level clustering effects were accounted for using a specified strategy

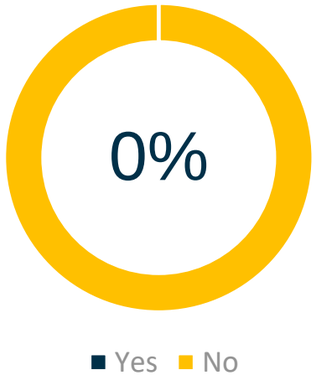
Results


Identification of studies via databases
Identification
Records identified from:
MEDLINE (n = 892)
Records removed *before screening*:
Duplicate records removed (n = 28)
Screening
Records screened
(n = 864)
Records excluded
(n = 680)
Reports assessed for eligibility
(n = 184)
Reports excluded:
Not an RCT (n = 12)
No skill-based intervention (n = 53)
Single surgeon (n = 70)
Included
Studies included in review
(n = 49)

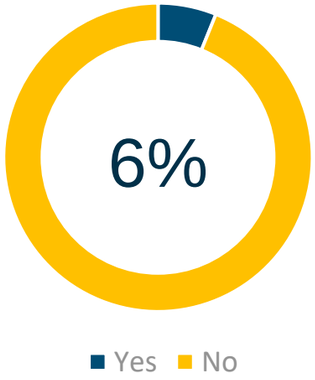
Results

- Proportion of studies (n = 49) that accounted for clustering effects in some way

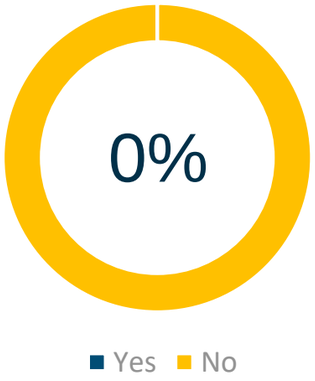
Sample Size Inflation



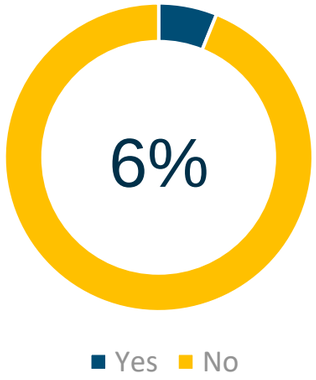
Stratification



Calculated Clustering Effect



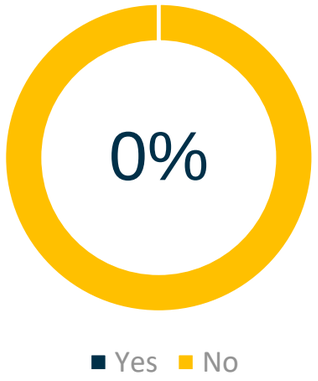
Statistical Analysis



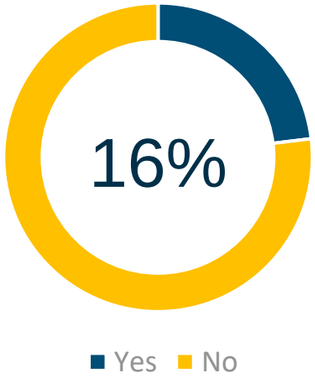
Results

- Proportion of studies with a biostatistician's expertise (n = 19) that accounted for clustering effects

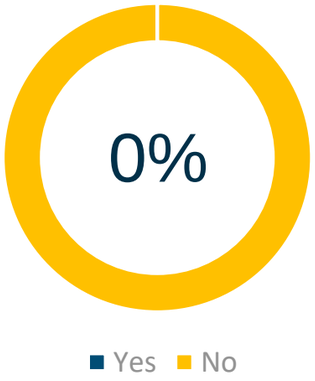
Sample Size Inflation



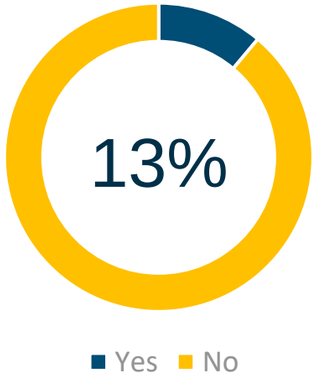
Stratification



Calculated Clustering Effect

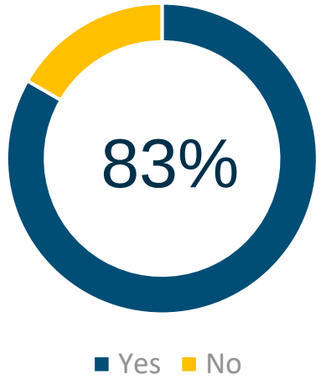


Statistical Analysis

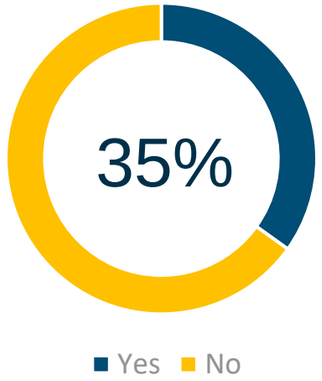


Results

- Proportion of studies that accounted for clustering in at least one way (n = 6) that used a biostatistician's expertise



- Proportion of studies that did not account for clustering in any way (n = 43) that used a biostatistician's expertise



Conclusion

The clustering effect in orthopaedic surgical trials is frequently overlooked, leading to potential biases in estimates of between-group treatment effects. It is crucial to emphasize the importance of accounting for clustering to enhance the validity and reliability of trial outcomes.

References

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