

Do Robots Protect Surgeons? A Systematic Review of Ergonomic Risks in Robotic and Laparoscopic Bariatric Surgery

Eeman Atif¹, Yuzhen Wu¹, Tamanna Bharani², Tony Huang¹, Krinal Mori¹

¹ Melbourne Medical School, The University of Melbourne, Melbourne, Australia

² Monash Medical School, Monash University, Melbourne, Australia



Background

Bariatric surgery volumes continue to rise globally, with laparoscopic and robotic techniques widely adopted as standard practice. Although minimally invasive approaches improve patient outcomes, they impose substantial ergonomic demands on operating surgeons. Work-related musculoskeletal symptoms are frequently reported in minimally invasive surgery (MIS). However, comparative evidence evaluating ergonomic risk between robotic and laparoscopic bariatric surgery remains limited and heterogeneous.

Aims

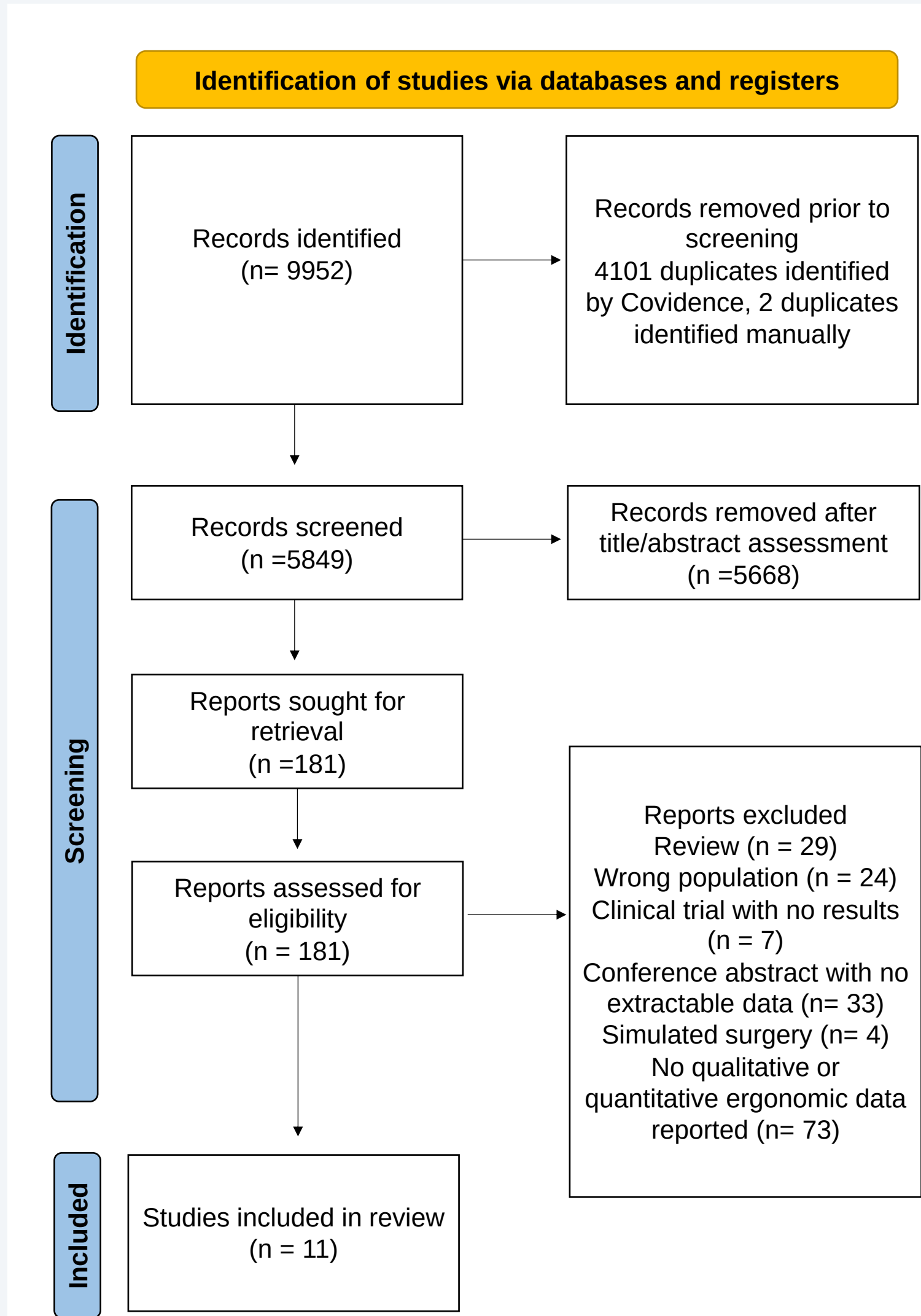
To synthesise qualitative and quantitative evidence evaluating ergonomic risks associated with robotic and laparoscopic bariatric surgery.

Methods

- Mixed-methods systematic review conducted in accordance with PRISMA guidelines. PROSPERO registered (CRD420251109094).
- Studies reporting on ergonomic outcomes during robotic and laparoscopic bariatric surgery (excluding simulated surgery) were included.
- Primary outcomes included objective ergonomic measures (REBA, RULA, electromyography) and subjective workload assessments (NASA-TLX, SURG-TLX).

Results

Eleven studies were included (≥183 surgeons; 307 procedures), predominantly sleeve gastrectomy and Roux-en-Y bypass (Figure 1).



Qualitative Findings

- Up to 66% of MIS bariatric surgeons report work-related musculoskeletal pain, most commonly involving the lumbar spine, cervical spine, and shoulders.
- Ergonomic burden impacts surgical practice: 27% report reduced case load and ~29% report impaired surgical performance.
- Modality-specific symptom patterns: laparoscopy → back/shoulder pain; robotics → neck fatigue.

Figure 1. PRISMA flow diagram

Table 1. Summary of objective ergonomic outcomes

Study	Tool	Key Comparative Finding
Hilt 2024	REBA	Higher overall strain in lap vs robotic; greater upper limb strain in lap with greater wrist strain in robotic ($p<0.01$).
Lawson 2007	RULA	Suboptimal upper-arm and lower-arm posture in lap; higher trunk loading in robotic ($p=0.029$).
Duckett 2023	EMG	Increased trapezius activation in lap; higher erector spinae activation in robotic ($p=0.007$).
Monfared 2019	EMG + motion analysis	≥50% operative time in sustained static positioning in both lap and robotic.

Discussion

Redistribution of Ergonomic Strain

- Robotic bariatric surgery was associated with lower overall objective and upper-extremity ergonomic risk.
- However, strain was redistributed to the wrist, trunk, and lumbar musculature.
- Qualitative reports describing robotics as “trading one set of aches for another” align closely with objective findings.

Objective–Subjective Discordance

- Perceived workload (NASA-TLX, SURG-TLX) did not consistently align with objective ergonomic strain (REBA, RULA, EMG).
- Subjective workload questionnaires may underestimate measurable postural strain, supporting the use of complementary assessment tools.

Workforce and Training Implications

- Bariatric surgeons report limited ergonomics training and institutional support: 85% report no formal ergonomics education, with trainee ergonomics education emerging as a key theme (43%).
- Modality-specific ergonomics training frameworks are needed to support long-term surgical career sustainability.

Conclusion

Robotic bariatric surgery reduces overall objective ergonomic risk compared with laparoscopy, but strain redistribution underscores the need for structured ergonomic optimisation.