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ADMINISTRATIVE INFORMATION

**Support** - This study was funded by the Chengdu Science and Technology Department (Grant number 2024-YF05-00339-SN).  
**Review Stage at time of this submission** - Preliminary searches.  
**Conflicts of interest** - None declared.  
**INPLASY registration number:** INPLASY202570080  
**Amendments** - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 20 July 2025 and was last updated on 20 July 2025.

INTRODUCTION

**Review question / Objective** In this meta-analysis, we systematically evaluated randomized controlled trials (RCTs) to assess the comparative effectiveness of metaverse-based teaching versus traditional learning methods in enhancing medical students' theoretical knowledge acquisition and clinical skills performance.

**Condition being studied** The metaverse-based simulation represents an advanced virtual ecosystem that integrates multiple technological domains, including computer programming, artificial intelligence, and virtual reality systems. This immersive digital environment enables the creation of sophisticated three-dimensional anatomical models and simulated surgical scenarios, providing medical students with interactive, high-fidelity learning experiences. In contrast, conventional pedagogical approaches

primarily depend on instructor-delivered didactic lectures or basic digital learning platforms, which offer limited capabilities for spatial visualization and practical skill development.

METHODS

**Participant or population** Medical students.  
**Intervention** Learn with Metaverse-Based Teaching tools.  
**Comparator** Learn with traditional teaching methods, including traditional lectures, textbooks, online searches.  
**Study designs to be included** Randomized Controlled Trials.  
**Eligibility criteria** Inclusion Criteria: RCTs comparing metaverse-based teaching and traditional teaching methods in medical education.

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**Exclusion Criteria:** non-RCT articles, non-metaverse-based teaching studies, studies unrelated to medical students, and articles for which the full text is unavailable.

**Information sources** Search electronic databases, including PubMed, EMBASE, and Cochrane Library, and search the references of the included articles.

**Main outcome(s)** The primary outcomes include scores in theoretical knowledge or practical skills after learning with metaverse-based teaching.

**Quality assessment / Risk of bias analysis** The quality of each outcome was rated using the GRADE group, categorized as very low, low, moderate, or high quality. Each RCT was evaluated for risk of bias using the Cochrane collaboration risk of bias tool, classifying studies as high, low, or unclear risk.

**Strategy of data synthesis** Meta-analysis was conducted using Review Manager (RevMan for Windows, Version 5.4). Risk ratio (RR) with 95% confidence interval (CI) were calculated for dichotomous variables. Standardized mean difference (SMD) with 95% CI were calculated for continuous variables. Variance was assessed using the chi-square test. A p-value < 0.05 was considered statistically significant.

**Subgroup analysis** Subgroup analyses evaluated how intervention duration (short-/long-term) and metaverse pedagogical approaches (self-directed learning vs. simulated patient scenarios) influenced knowledge and skill outcomes.

**Sensitivity analysis** Perform sensitivity analysis through different subgroups and model construction.

**Country(ies) involved** China.

**Keywords** Metaverse-Based Teaching, Traditional Teaching, Medical Education.

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