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The efficacy of bilingual immunology teaching on undergraduates in China: a systematic review and meta-analysis

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INTRODUCTION

Review question / Objective This systematic review and meta-analysis aims to comprehensively evaluate the effectiveness of bilingual immunology instruction among undergraduate students in China.

Rationale Bilingual education refers to an instructional approach in which two distinct languages are employed as mediums of instruction. This educational model has gained increasing popularity in China. Types of bilingual education include transitional bilingual education (TBE), dual-language immersion (DLI) and maintenance bilingual education (MBE) according to the Longman Dictionary of Applied Linguistics. Current research on bilingual education in China offers limited insight into preferences for various bilingual education models and its effectiveness in improving students' English competence. However, the most widely adopted approach is MBE in immunology instruction, which aims to maintain and enhance bilingual proficiency while preserving the native language. Although numerous studies have examined the effectiveness of bilingual immunology teaching in Chinese universities and colleges, most of these investigations are limited to specific institutions. Furthermore, the implementation of bilingual immunology teaching lacks a consistent guideline, and a comprehensive evaluation of such teaching practices remains inconclusive. Immunology, one of the most intricate subjects to master and teach, is a rapidly advancing discipline and a core component of the curriculum in the education of students within the fields of medicine and biological sciences. Bilingual teaching in China has been developing for over two decades, with variations observed in both instructional models and the effectiveness of implementation across different disciplines and institutions. To date, limited research has been conducted on bilingual teaching in China, particularly regarding its overall

effectiveness in the context of the immunology curriculum. A notable limitation in the current body of research is the lack of high-quality studies and rigorous evaluation designs to effectively assess the potential impact of bilingual education. While it is undeniable that teachers' competencies play a crucial role in the implementation of bilingual education, this study emphasizes the influence of bilingual immunology teaching on students, based on data extracted from published research. Student-based evaluation of bilingual teaching encompasses two primary dimensions: student performance and student attitudes or motivation. This study aims to systematically evaluate the effectiveness of bilingual teaching implementation in immunology among Chinese undergraduate students, as demonstrated by course performance, professional English proficiency, and competence in English application. The findings may serve as a reference for future reforms and strategic planning initiatives aimed at enhancing the effective implementation of bilingual immunology teaching in HE in China.

Condition being studied Numerous studies have examined the effectiveness of bilingual immunology teaching in Chinese universities and colleges, most of these investigations are limited to specific institutions, and the latest published study relating to bilingual immunology teaching in China is 2015, the overall efficacy remains unclear, though the Chinese Ministry of Education has issued "Several Opinions on Strengthening Undergraduate Teaching in Colleges and Universities and Improving Teaching Quality" since 2001, highlighting the significance of bilingual teaching in higher education. Bilingual education has been implemented for over 20 years in China, immunology is abstract and intricate with characteristic of both hard to learn and teach, which requires student engage in active-learning. The effectiveness of bilingual immunology instruction and its role in facilitating student-centered learning, as well as its integration with other pedagogical approaches to promote higher-order learning will also be discussed.

METHODS

Search strategy A search of the Chinese Science Citation Database of China National Knowledge Infrastructure (CNKI), Wanfang Database, VIP database, SinoMed, Web of Science, the Cochrane Library, PubMed, and two key academic search engines was conducted to collect studies published from 2001 to July 18, 2025. The following key words were searched: ("immunology" or "immunologic*) AND ("bilingual education" OR "bilingual teaching") AND ("undergraduates in China" OR "Chinese undergraduates"). Two independent authors conducted data extraction and quality assessment of the final studies based on strict eligibility.

Participant or population Chinese undergraduate students receiving bilingual immunology teaching.

Intervention Bilingual immunology teaching/education/instruction.

Comparator A single meta-analysis to evaluate the efficacy of bilingual immunology teaching in Chinese universities/colleges.

Study designs to be included (a) studies focusing on bilingual immunology education implemented in Chinese higher education institutions; (b) research that measured the outcomes of bilingual immunology education through specific indicators, including course performance, professional English proficiency, and competence in English application; and (c) studies reporting a specified sample size.

Eligibility criteria
The inclusion criteria is refered to 15. Study designs to be included.
The exclusion criteria were as follows: (a) duplicate publications; (b) articles with inaccessible full texts or lacking clearly defined outcomes that could be extracted; (c) articles published in languages other than Chinese or English; and (d) studies focusing on populations other than undergraduate students.

Information sources Seven databases, including CNKI, Wanfang Data, VIP, SinoMed, Web of Science, The Cochrane Library, and PubMed, and two academic searching engines Baidu Scholar and Google Scholar.

Main outcome(s) Studies published from 2001 to July 18, 2025 were searched. The included studies with a clear indciator to reflect the effects of bilingual immunology teaching. The indicators include academic performance, professional English proficiency, and competence in English application. A single meta-analysis was employed to make data synthesis showing by RD or OR along with their corresponding 95% CIs, as well as p-values or adjusted p-valuesRD.

Data management Duplicate publications were removed using NoteExpress (Version 4.0.09855, Tsinghua University LibraryEdition).
Data extraction encompassed the following elements: article title, publication year, journal

name, publication language, total number of authors, institutional affiliations of authors, the number of institutional affiliations, the sample size, the outcomes of bilingual teaching, bilingual teaching model, proportion of English/Chinese in instruction, examination/answer and assignment, the type of textbook. This process was conducted independently by two authors using Excel spreadsheets.

Quality assessment / Risk of bias analysis Study quality was assessed by the MINORS for non-randomized studies, which was graded as low (score 0-8), moderate (score 9-16) and high (score 17-24).
Risk of bias was assessed by ROBINS-I V2 and judged as low, moderate, serious and critical following signaling question under each domain. Judgement of overall risk of bias in each study was in consistent with the highest grade appearing in any domain.

Strategy of data synthesis The RD or OR along with their corresponding 95% CIs in each study, as well as p-values or adjusted p-values, were computed to assess the effectiveness of the bilingual teaching demonstrating by forest plots. Statistical significance was defined as $p < 0.05$.

Subgroup analysis Not applicable.

Sensitivity analysis Heterogeneity across studies was evaluated using the I^2 statistic, where I^2 values of 0–25% were considered to indicate low heterogeneity, 26–50% moderate heterogeneity, and values above 75% were deemed to represent substantial heterogeneity. Sensitivity analysis was performed to assess the stability of the pooled results using Stata 17.0 statistical software by omitting one study at a time. Potential publication bias was examined through visual inspection of funnel plots and Egger's linear regression tests employing Stata 17.0 statistical software.

Language restriction Only studies published in Chinese and English were searched.

Country(ies) involved China/Lanzhou University.

Keywords Systematic Review, Meta-Analysis, Bilingual Immunology Teaching/Education, Chinese Undergraduates, Medical and life Science Education.

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