Comparing Medical Training Costs Internationally: A Systematic Review

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Abstract

Background: Acquiring a thorough understanding of the expenses linked to the education of health sciences students is crucial for effective university planning, budgeting, and overall preparedness. This systematic review aimed to identify and compare the per capita costs associated with educating medical and other health science students internationally—particularly emphasizing the context of Iran.

Methods: A systematic review was conducted in 2023 according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The search covered the period from January 1, 2000, to November 11, 2022, using MeSH and EMTREE terms. Databases such as PubMed, Scopus, Web of Science, Embase, and Iranian databases were searched. Manual searches were performed using Google and Google Scholar.

Results: The study retrieved 1336 publications from bibliometric databases and, following thorough screening, included 8 relevant articles from 5 countries (Australia, Iran, United States, Thailand, and Vietnam). An additional 17 relevant articles from Iranian databases were also included. Based on USD purchasing power parity (PPP) 2019, the results show that the mean per capita cost of training a medical student for 1 academic year in Iran is $61,493.86 (range, $28,102-$133,603; standard deviation, $35,476.03). In comparison, the cost of training a medical student for 1 year is $263,305 in the United States and $44,674 in Australia. In Thailand and Vietnam, a 6-year medical program costs is $284,058 and $69,323, respectively. Moreover, according to most studies, training students in other health sciences in Iran for 1 academic year generally costs <$20,000 (PPP 2019).

Conclusion: The study reveals that the costs associated with medical student education in Iran exceed that of most countries, second only to the United States. These findings highlight the importance of such data in improving the efficiency, sustainability, and informed resource allocation of global medical education programs for future planning and budgeting.

Keywords: Cost, Education, Medical Student, Training

Introduction

The rising costs of medical education have gained considerable traction in recent times, although historical references to this concern date back to the 18th century (1, 2). The continued increase in the cost of medical education has raised significant concerns about its impact on the field of medicine, both at the macro and microeconomic

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↑What is "already known" in this topic:
Previous research has explored the cost of medical education within Iran and across universities. However, there has been no previous study that compares these training costs nationally and internationally.

→What this article adds:
This study provides a comprehensive analysis of the costs of medical education, both nationally and internationally. It also identifies cost differences between university faculties and between different academic disciplines. The results of the study provide valuable insights for the design of targeted reforms in the allocation of resources to undergraduate education.

levels (3) and as a global trend, it transcends national boundaries (4).

These escalating costs have led academic medical centers to increase tuition fees due to inflated curriculum costs, thereby shifting some of the financial burden to medical students (5, 6). This shift in cost-sharing affects not just payers but also the wider community as it affects the delivery of medical services (7). To illustrate the magnitude of this issue, a comparison of tuition fees in the United States between 1992 and 2013 shows a nearly 400% increase in public medical school tuition fees and over a 180% increase in private medical school tuition fees (8). Given the rapidly changing economic and educational landscape, a comprehensive reassessment of medical education costs is essentiel. Therefore, a systematic review focusing on the costs associated with medical education is imperative. This review is essential for informed decision-making and resource optimization in a significant investment such as medical education, to benefit both students and institutions (9, 10).

This systematic review aimed to provide comprehensive insight into medical education costs and develop evidence-based policies to ensure financial sustainability. In addition, the focus on Iran in this review is significant because of its unique health and education systems, providing lessons for other countries facing similar challenges. The review also highlights the likelihood of variation in medical education costs within Iran, influenced by factors such as regional disparities, differences in infrastructure, faculty salaries, and local economic conditions. By exploring these variations and comparing them internationally, policymakers can derive essential context for effective policy and financial management practices in medical education.

Therefore, in this systematic review, the authors aimed to examine and compare the per capita cost of medical and other health science education in Iran and several other countries.

Methods
Study Design
This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline (11). The completed PRISMA 2020 checklist can be found in the Appendix 1.

Search Strategy and Information Sources
The search included articles published between January 1, 2000, and November 11, 2022. Relevant publications on the cost of medical student education were identified by searching electronic bibliometric databases, including PubMed, Scopus, Web of Science, and Embase, by combining Medical Subject Headings (MeSH) or EMTREE terms with free text. Databases were searched using keywords and terms for "(cost OR price OR economic) AND (education OR teaching OR training OR curriculum) AND ((student AND medical) OR (student AND med))." The adapted database search strategies are presented in the Appendix 2.

Furthermore, the national databases Scientific Infor-

mation Database (SID) and Magiran were searched to identify relevant publications on medical education costs in Iran. A manual search of Google and Google Scholar was also conducted to identify relevant literature.

Eligibility Criteria
Inclusion Criteria
The study aimed to include research that examined the costs associated with the education of medical and other health science students, focusing specifically on these costs from the provider's perspective. The scope of the search was limited to studies conducted in university and school settings.

Exclusion Criteria
Studies that calculated the clinical costs of training students in university-affiliated hospitals were excluded from the analysis. This decision was made to clearly distinguish between educational and clinical costs (12-14). In addition, articles published in bibliometric databases in languages other than English and nonoriginal papers, such as abstracts or clinical reports, were excluded. Furthermore, articles without accessible full text were not considered for inclusion.

Selection Criteria
First, duplicates were excluded using Endnote software. Then, the titles and abstracts of the included articles were checked by 2 reviewers. Unrelated articles were removed, and those suitable for full-text review were identified. Subsequently, both reviewers independently read the full text of the articles; finally, eligible articles were included in the study. A third reviewer made the final decision in case of disagreements between the reviewers.

Data Extraction
Data were extracted using an extraction table created in Excel software. The table summarizes the characteristics of the included studies and their main findings. The characteristics of the included studies include the name of the first author, year of publication, country, setting (university or school), currency, year of cost analysis, costing method (eg, activity-based costing) and time horizon. The main findings include the cost analysis results of the studies.

Data Synthesis
In this study, the cost data were converted to US dollars (USD) 2019 using the Campbell and Cochrane Economics Methods Group Evidence for Policy and Practice Information and Coordination Centre (CCEMG-EPPI-Centre) cost converter (Version 1.6, last update: April 29, 2019). This converter incorporates the International Monetary Fund (IMF) methodology for adjusting costs based on purchasing power parity (PPP) values (15).

The IMF method is used to adjust costs based on PPP. This involves converting costs to the respective country's current-year cost using the Gross Domestic Product Deflator (GDPD) index. This first step ensures that costs are adjusted to the specific year's value within the country of

interest, considering local inflation and economic indicators captured by the GDPD index.

Having been adjusted to the current year's costs within the country, the costs are converted to USD using PPP exchange rates. These rates provide a standardized comparison by considering differences in purchasing power between countries, ensuring that costs are expressed in a common currency and reflect the actual purchasing power within each country.

Assessment of Methodological Quality

To assess the methodological quality of the included studies, we used a streamlined adaptation of Drummond et al's checklist, a tool for assessing economic evaluations endorsed by the British Medical Journal (16). The checklist was adapted to include the following key criteria:

Study Design

It examined the clarity and reporting of the study objectives, emphasizing the articulation and justification of the economic perspective (ie, the parties bearing the costs).

Data Collection

This criterion assessed the comprehensive reporting of resource use and unit cost data collection methods.

Analysis and Interpretation of Results

It focused on assessing the rigor and coherence of the authors' approaches to analyzing and interpreting the results.

Results
Screening Results

A total of 1336 articles were retrieved from bibliometric databases, including PubMed, Scopus, Web of Science, and Embase, in this study. After removing duplicates (N = 663 articles), 673 articles underwent title and abstract screening. After title and abstract screening, 45 articles remained for full-text screening. Finally, 8 articles were included in the study. After screening the relevant articles extracted from Iranian scientific databases, 17 additional articles were included in the study. A total of 25 articles included in this study were reviewed using this method (Figure 1).

Study Characteristics

The reason for separately presenting the specifications of studies related to bibliographic databases is to facilitate comparisons between different countries, including characteristics such as the number of articles by country.
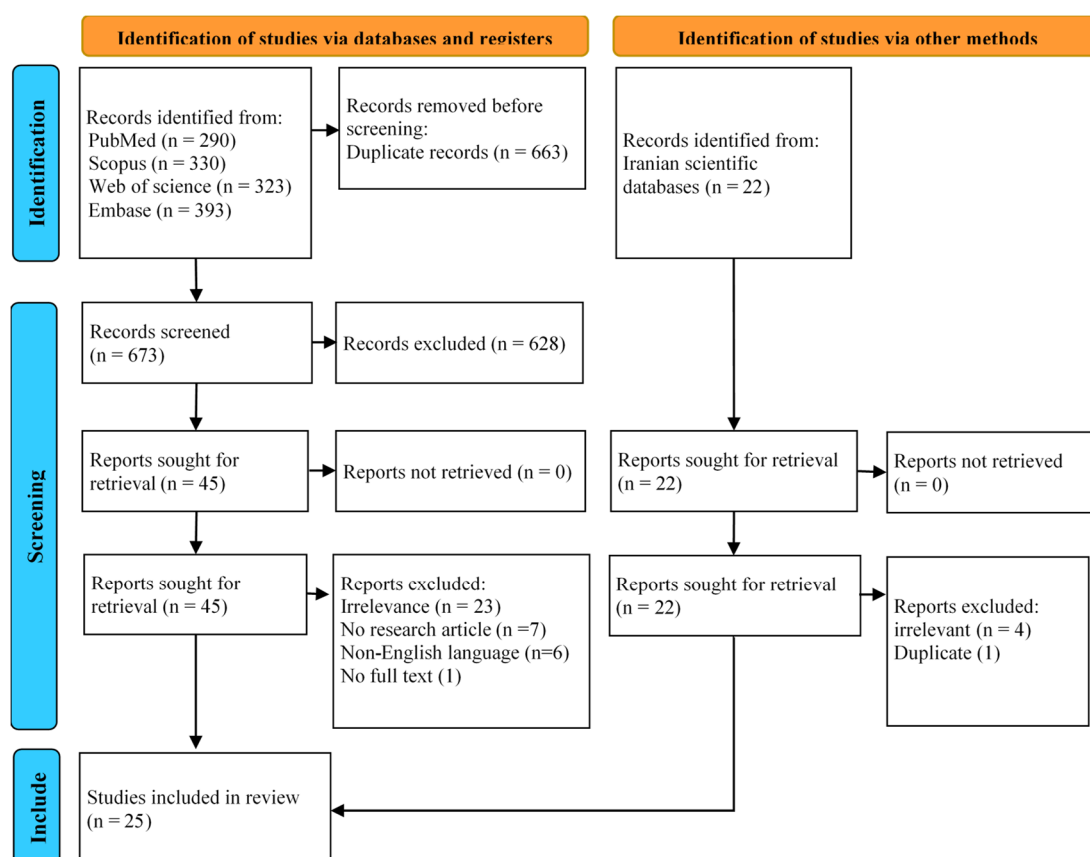

Identification of studies via databases and registers

Identification	
Records identified from: PubMed (n = 290) Scopus (n = 330) Web of science (n = 323) Embase (n = 393)	Records removed before screening: Duplicate records (n = 663)

Identification of studies via other methods

Records identified from:
Iranian scientific databases (n = 22)

Screening

Records screened (n = 673)	Records excluded (n = 628)
Reports sought for retrieval (n = 45)	Reports not retrieved (n = 0)
Reports sought for retrieval (n = 45)	Reports excluded: Irrelevance (n = 23) No research article (n =7) Non-English language (n=6) No full text (1)

Reports sought for retrieval (n = 22)	Reports not retrieved (n = 0)
Reports sought for retrieval (n = 22)	Reports excluded: irrelevant (n = 4) Duplicate (1)

Include

Studies included in review
(n = 25)

Figure 1. A PRISMA diagram of the search and selection process

Table 1. Summary characteristics of included studies from bibliometric databases

First author (Publication year) (REF)	Country	Setting		Currency (Costing year)	Costing Method	Study course
		University	School			
B. Pouragha (2020) (29)	Iran	Alborz University of Medical Sciences	Public Health School	USD (2019)	Activity-based costing model	One academic year
W. P. Luan (2021) (19)	USA	Uniformed Services University (USU)	Medical School	USD (2017)	NR	One academic year
M. Namazi (2021) (17, 30)	Iran	Shiraz University of Medical Sciences	Medical School	IRR (2016)	Activity-based costing model	One academic year
A. J. Smolka (2015) (31)	USA	Medical University of South Carolina (MUSC)	College of Graduate Studies	USD (2011)	NR	One academic year
R. K. Oates (2013) (21, 22)	Australia	University of Sydney	Medical School	AUD (2010)	NR	One academic year
E. Gammon (2011) (32)	USA	University of Texas-Houston	Medical School	USD (2007)	Construction model	One academic year
T.Vimolket (2003) (23)	Thailand	Chulalongkorn University	Medical School	THB (2000)	Simultaneous equation method	An academic course (six years)
W. J. Bicknell (2001) (20)	Vietnam	Thai Binh University of Medicine and Pharmacy	Medical School	VND (1997)	A Generalizable model	An academic course (six years)

NR, not reported or incomprehensible.

Table 1 summarizes the characteristics of the 8 studies extracted from bibliometric databases between 2000 and 2022. These studies were conducted between 1997 and 2019 in 5 countries. Specifically, 3 studies were conducted in the United States, 2 in Iran, 1 in Australia, 1 in Thailand, and 1 in Vietnam. All included studies were cross-sectional and retrospective and mainly used an activity-based costing approach. Of the 8 studies included, 6 studies (80%) were related to medical school. They examined the costs of training medical students, and 2 studies (20%) were related to the College of Graduate Studies and the School of Public Health. All studies calculated the costs associated with medical students for 1 academic year, except 2 studies that evaluated the costs over the entire academic period (6 years) required to train a medical graduate.

Table 2 summarizes the characteristics of the 17 included studies extracted from Iranian databases between 2000 and 2022. The earliest study was conducted in 2002, while the most recent was conducted in 2019. Most studies used activity-based costing to calculate costs, except 3 studies. Most studies calculated costs for 1 academic year, except for 3 studies. A total of studies were conducted in Iran, including 2 studies from bibliographic databases (Table 1) and 17 studies extracted from Iranian databases.

Figure 2 shows the distribution of studies by university in Iran. Shiraz University of Medical Sciences had the highest number of studies (n = 4), followed by Kerman University of Medical Sciences (n = 3), and Tabriz University of Medical Sciences (n = 2). In addition, 12 universities (Alborz, Birjand, Fasa, Gonabad, Iran, Isfahan, Mazandaran, Qom, Saveh, Shahid Beheshti, Tehran, and Yazd Universities of Medical Sciences) each published 1 figure (Figure 2). Shiraz, Yazd, and Fasa Universities of Medical Sciences exceed the total number of articles because of the number of joint articles or studies. Most studies were conducted in the Faculty of Medicine and the Faculty of Management and Medical Information.

Cost Analysis

Based on the USD PPP 2019 metrics, the results of our study indicate that in the US, the per capita cost of educating a medical student for a single academic year is $263,305, while the per capita cost of educating a biomedical graduate student ranges from $19,882 to $27,735. In Australia, the total cost of medical education, including infrastructure costs, was $44,674 for 1 year of education and $42,166 excluding infrastructure costs. In Thailand and Vietnam, the per capita cost of producing a medical graduate through a 6-year academic program was $284,058 and $69,323, respectively (Table 3).

Five studies independently calculated the per capita cost of medical student education in Iran. Using the 2019 USD PPP, these studies found that the per capita cost of medical student education for a single academic year was estimated to be $57,571 in 1 study from Shiraz and notably $133,603 in another study. In Birjand, the cost was reported to be $28,102, while it was $31,745 in Gonabad. Furthermore, a survey conducted in 3 universities of medical sciences, namely, Shiraz, Fasa, and Yazd, reported these costs to be $52,793, $74,586, and $52,057, respectively (Table 3 & Figure 3). Consequently, the analysis shows that the mean per capita cost of training a medical student for 1 academic year in Iran is $61,493.86 (with a maximum of $133,603 and a minimum of $28,102; standard deviation, $35,476.03). Furthermore, at Mazandaran University of Medical Sciences, the per capita cost of educating all medical students, including medical and nonmedical students, was estimated to be $42,076 (Table 3).

The results of this systematic review showed that 6 included studies were conducted in the Faculty of Management and Medical Information, reporting cost ranges for the education of students in the Faculty of Management and Medical Information at different universities. The per capita cost for 1 academic year in this faculty ranged from $6,148 to $30,808. This range also applies to the Faculty of Public Health and Nursing and Midwifery. In addition,

Table 2. Summary characteristics of included studies (Extracted from Iranian databases)

Study (Publication year)	Country	Setting University	Setting School	Currency (Costing year)	Costing Method	Study course
F. Abedi (2022) (18)	Iran	Birjand University of Medical Sciences	All Schools	IRR (2018)	Activity-based costing model	One academic year
R. Goudarzi (2021) (33)	Iran	Kerman University of Medical Sciences	Medical School	USD (2018)	Top-down approach	One academic year
J. M. Nasirabad (2021) (34)	Iran	Tabriz University of Medical Sciences	Management and Medical Information School	IRR (2018)	Activity-based costing model	One academic year
A. Rostamzadeh (2022) (35)	Iran	Tabriz University of Medical Sciences	Management and Medical Information School	IRR (2016)	Activity-based costing model	One academic year
N. Shahraki (2021) (36)	Iran	Shiraz University of Medical Science	Management and Medical Information School	USD (2016)	Activity-based costing model	An academic course
R. Esmaeili (2018) (37)	Iran	Gonabad University of Medical Sciences	All Schools	IRR (2016)	Step-Down Method	One academic year
M. T. Gholamhoseini (2019) (38)	Iran	Kerman University of Medical Sciences	Management and Medical Information School	IRR (2015)	Activity-based costing model	One academic year
S. Moradi (2018) (39)	Iran	Mazandaran University of Medical Sciences	Medical School	IRR (2015)	Activity-based costing model	One academic year
M. Rezaei (2018) (40)	Iran	Saveh University of Medical Sciences	Nursing and Midwifery School	IRR (2014)	Activity-based costing model	One academic year
S. Ghasempour (2016) (24)	Iran	Tehran University of Medical Sciences	Allied Medicine School	IRR (2013)	Activity-based costing model	One academic year
A. A. Haghdoost (2014) (25)	Iran	Kerman University of Medical Sciences	Public Health School	IRR (2011)	Activity-based costing model	One academic year
A. Rajabi (2012) (41)	Iran	Shiraz, Fasa, and Yazd Universities of Medical Sciences	All Schools	IRR (2008)	Activity-based costing model	One academic year
J. Kojuri (2010) (42)	Iran	Shiraz University of Medical Sciences	Medical School	IRR (2007)	NR	One academic year
K. Saeid (2007) (43)	Iran	Isfahan University of Medical Sciences	Management and Medical Information School	IRR (2007)	Activity-based costing model	One academic year
F. Ebadi Azar (2006) (44)	Iran	Iran University of Medical Sciences	Management and Medical Information School	IRR (2007)	Activity-based costing model	One academic year
D. R. Mofid (2006) (45)	Iran	Shahid Beheshti University of Medical Sciences	Dentistry School	IRR (2004)	NR	An academic course (6 years)
A. Barati (2005) (46)	Iran	Qom University of Medical Sciences	Nursing School	IRR (2002)	Activity-based costing model	An academic course (4 years)

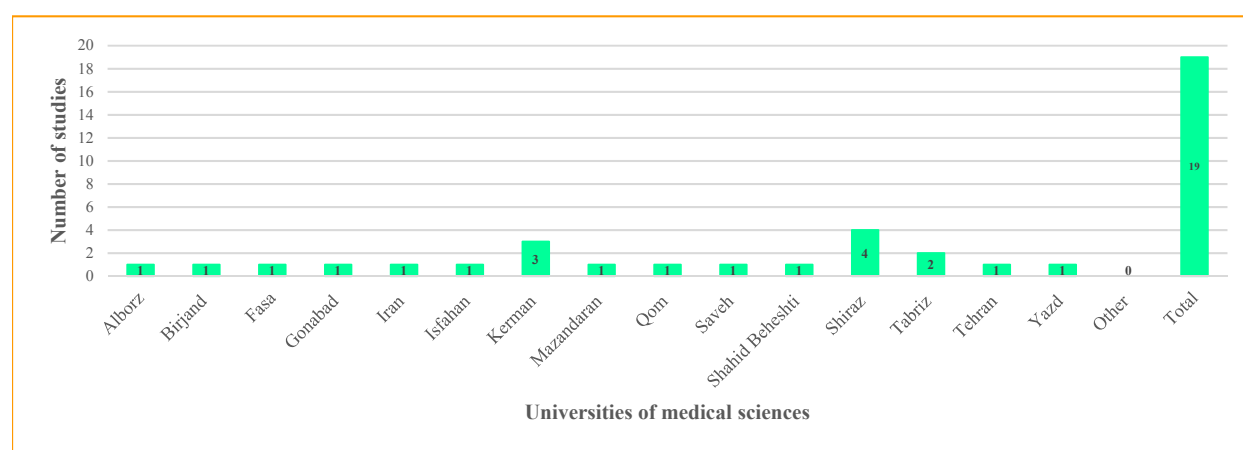NR, not reported or incomprehensible.

Figure 2. The number of included studies by universities of medical sciences in Iran

the cost of education for 1 academic year in different faculties typically ranged from about $100,000 to $177,000 per student (Table 3).

In 4 of the included studies conducted in Iran, the per capita cost of student education for Doctor of Philosophy (PhD), Master of Sciences (MSc), and Bachelor of Sciences (BSc) programs was calculated in 2019 USD PPPs. The cost per student for these academic levels ranged

Table 3. The findings of included studies, and the per capita cost of educating health science students

Study (Publication year)	Per capita cost of educating a student per one academic year or an academic course- indicated by * (year costing)	PPP is not considered **		PPP is considered
		IRR2019	USD2019	USD2019
The findings from bibliometric databases				
B. Pouragha (2020) (29)	For students of the Public Health faculty of Alborz University of Medical Sciences = $4,778 US (1 USD = 30600 Rials) (2019)	146,206,800 R	$3,481	$9,273
W. P. Luan (2021) (19)	For Medical students of Uniformed Services University (USU) = $253,000 per year (more than 1 million dollars total over a 4-year curriculum) (2017)	-	-	$263,305
M. Namazi (2021) (17, 30)	For Medical students of Shiraz University of Medical Sciences = 445,282,178 Rials (2016)	907,673,481 R	$21,611	$57,571
A. J. Smolka (2015) (31)	For biomedical students of Medical University of South Carolina (MUSC) = Lower $17,363, Upper $24,223 (2011)	-	-	$19,882 $27,735
R. K. Oates (2013) (21, 22)	For Medical students at the University of Sydney = $53 093 US, and $56,250 US including infrastructure costs (2010)	-	-	$42,166 $44,674
E. Gammon (2011) (32)	For students of the Medical faculty of the University of Texas-Houston = $61,862 US (2007)	-	-	$75,145
T.Vimolket (2003) (23)	For producing a Medical Doctor of Chulalongkorn University = 2,161,124 Baht, and cost of producing a medical graduate= 2,174,091 Baht for a 6-years academic course (2000) *	-	-	$282,364 $284,058
W. J. Bicknell (2001) (20)	For Medical graduate of Thai Binh University of Medicine and Pharmacy = 111,462,989 Dong (US$9,527) for a 6-years academic course (1997) *	-	-	$69,323
The findings from Iranian databases				
F. Abedi (2022) (18)	For students of All faculties of Birjand University of Medical Sciences = 234,437,263 Rials for all students, 324,827,214 Rials for medical students (2018)	319,782,281 R 443,077,974 R	$7,614 $10,549	$20,283 $28,102
R. Goudarzi (2021) (33)	For students of the Medical faculty of Kerman University of Medical Sciences = $18,365 US for a parasitology PhD student, $11,144 US for a parasitology MSc student, $7,821 US for a mycology MSc student (1 USD = 42000 Rials) (2018)	1,052,126,542 R 638,437,146 R 448,063,255 R	$25,051 $15,201 $10,668	$66,733 $40,494 $28,419
J. M. Nasirabad (2021) (34)	For students of the Management and Medical Information faculty of Tabriz University of Medical Sciences = 356,092,000 Rials (2018)	485,724,456 R	$11,565	$30,808
A. Rostamzadeh (2022) (35)	For students of the Management and Medical Information faculty of Tabriz University of Medical Sciences = 105,000,000 Rials (2016)	214,034,426 R	$5,096	$13,576
N. Shahraki (2021) (36)	For students of the Management and Medical Information faculty of Shiraz University of Medical Sciences = $25,567 US for all students, $95,303US for PhD students, $20,976 US for MSc students, $24,347 US for BSc students (1USD=30,320 Rial) (2016) *	1,580,168,143 R 5,890,200,827 R 1,296,421,441 R 1,504,766,057 R	$37,623 $140,243 $30,867 $35,828	$100,225 $373,596 $82,227 $95,442
R. Esmaeili (2018) (37)	For students of All faculties of Gonabad University of Medical Sciences = 245,535,348 Rials (2016)	500,504,927 R	$11,917	$31,745
M. T. Gholamhoseini (2019) (38)	For students of the Management and Medical Information faculty of Kerman University of Medical Sciences = 159,469,350 Rials (2015)	330,275,137 R	$7,864	$20,948
S. Moradi (2018) (39)	For Medical students of Mazandaran University of Medical Sciences = 320,301,348 Rials (2015)	663,372,439 R	$15,795	$42,076
M. Rezaei (2018) (40)	For students of the Nursing and Midwifery faculty of Saveh University of Medical Sciences = 54,596,860 Rials (2014)	113,560,367 R	$2,704	$7,202
S. Ghasempour (2016) (24)	For students of Allied Medicine faculty of Tehran University of Medical Sciences = 118,312,679 Rials for PhD students, 76,714,824 Rials for MSc students, and 42,312,537 Rials for BSc students (2013)	272,759,897 R 176,859,553 R 97,547,983 R	$6,494 $4,211 $2,323	$17,300 $11,218 $6,187
A. A. Haghdoost (2014) (25)	For students of the Public Health faculty of Kerman University of Medical Sciences = 31,110,000 Rials for all students, 70,370,000 Rials for PhD students, 54,490,000 Rials for MSc students, 26,760,000 Rials for BSc students (2011)	120,581,738 R 272,752,713 R 211,202,150 R 103,721,225 R	$2,871 $6,494 $5,029 $2,470	$7,648 $17,300 $13,396 $6,578
A. Rajabi (2012) (41)	For Medical students of Shiraz, Fasa, and Yazd Universities of Medical Sciences = 143,172,499 Rials, 202,273,240 Rials, and 141,176,854 Rials, respectively (2008)	832,346,511 R 1,175,934,113 R 820,744,645 R	$19,818 $27,998 $19,542	$52,793 $74,586 $52,057
J. Kojuri (2010) (42)	For Medical students of Shiraz University of Medical Sciences = 303,400,000 Rials (2007)	2,106,420,312 R	$50,153	$133,603
K. Saeid (2007) (43)	For students of the Management and Medical Information faculty of Isfahan University of Medical Sciences = 13,963,497 Rials (2007)	96,944,607 R	$2,308	$6,148
F. Ebadi Azar (2006) (44)	For students of the Management and Medical Information faculty of Iran University of Medical Sciences = 18,586,807 Rials (2007)	129,042,939 R	$3,072	$8,184
D. R. Mofid (2006) (45)	For students of Dentistry of Shahid Beheshti University of Medical Sciences = 221,050,474 Rials for a 6-years academic course (2004) *	2,597,820,613 R	$61,853	$164,771
A. Barati (2005) (46)	For students of Nursing faculty of Qom University of Medical Sciences = 171,563,000 Rials for a 4-years academic course (2002) *	2,801,309,111 R	$66,698	$177,678

*Reported for an academic course. **PPP is not considered, and the average exchange rate in 2019 according to the report of the Central Bank of Iran was used to convert Iranian Rial to US Dollar (1 USD=42000 IRR). -Studies conducted in other countries.

from $6000 to $66,000 for 1 academic year, with PhD education being the most expensive and BSc education being the least costly (Table 3).

Quality Assessment

All studies included in the comparative cost analysis met the British Medical Journal quality criteria for economic evaluations (16), indicating a consistently high standard across the studies. Of the 25 studies that under-
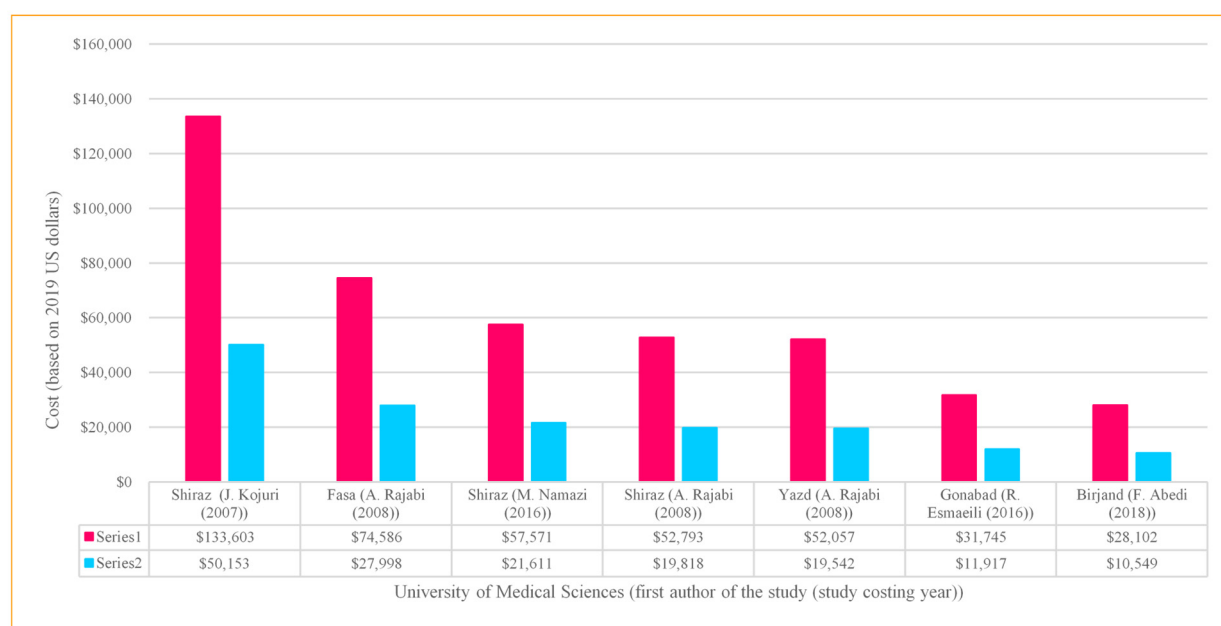
Figure 1. Per capita cost of training a medical student per one academic year in Iran based on 2019 US dollars
In series 1, purchasing power parity (PPP) is considered. But in the series 2, PPP is not considered, and the average exchange rate in 2019 according to the report of the Central Bank of Iran was used to convert Iranian Rial to US Dollar (1 USD = 42000 Rials).

went qualitative assessment, all clearly defined the research question and the target population and effectively described the study setting (university/school) and location. However, in 92% of the studies (n = 23), the economic perspective was not reported, but the information provided allows interpretation. In particular, all studies were careful to report their sources of resource use and unit costs, including currency and the year of cost, as well as comprehensive methods for assessing resource use. While the majority (80%) reported sufficiently on the methodology used to estimate costs, there is room for improvement regarding this aspect. Furthermore, while all studies reported their time horizon, most focused on estimating costs within a relatively short time frame of up to 1 year. Discount rates reporting was only required in 1 study and was not done. Despite these nuances, all studies effectively addressed their research questions, drew conclusions from the reported data, and appropriately accompanied their conclusions with relevant caveats to ensure the robustness of their findings. Detailed qualitative assessment results of all included studies are presented in Table 4.

Discussion

This study was the first systematic review to synthesize the cost of medical education in Iran and internationally. Our analysis of the Iranian data suggests that health economics, particularly costing studies, is still developing in Iran and is not yet a mature decision-support tool. Notably, study methodologies were relatively limited, with activity-based costing predominant. Future studies should explore more robust costing methods to improve accuracy.

Our results revealed significant variation in the per capita cost of training medical students annually across universities within Iran and globally. Within Iran, the spectrum ranged from the highest reported cost of $133,603 attributed to Shiraz University of Medical Sciences (17) to the lowest reported cost of $28,102 associated with Birjand University of Medical Sciences (18). Comparatively, international variations were evident, with the US reporting the highest annual cost of training a medical student at $263,305 (19) compared with $69,323 in Vietnam for a 6-year academic course (20). Other countries such as Australia (21, 22) and Thailand (23) reported costs of $44,674 for 1 academic year and $284,058 for a 6-year academic course, respectively. However, some of these discrepancies may be due to differences in study methods and cost structures between universities and countries. In addition, costs have changed significantly worldwide over the past 2 decades. Consequently, another factor contributing to these cost differences may be the different periods during which the studies were undertaken.

Furthermore, our review consistently highlighted that the per capita cost of educating PhD students exceeded that of MSc and BSc students across all programs. While the majority confirmed that PhD education was the most expensive, there were cases where the cost of educating an MSc student exceeded that of a BSc student (24, 25). Nevertheless, PhD education was generally the most expensive and BSc education the least expensive.

Participating in the costs of higher education or shifting some of these costs to parents and students is a global trend. This is evidenced by the rise in tuition fees, increased costs for essentials such as food and accommodation, and a concurrent reduction in scholarships. Studies

Table 4. Results of the risk of bias assessment for included studies

Column headers (grouped):
- **Study design:** Research question; Target population; Setting and location; Economic perspective
- **Data collection:** Sources of resource use & unit costs; Cost estimation methodology
- **Analysis and interpretation of results:** Currency and cost year; Resource use valuation; Time horizon; Discounting costs; The answer to the research question is given; Conclusion follow from the data reported; Conclusions accompanied by appropriate caveats

Studies:
- B. Pouragha (2020)
- W. P. Luan (2021)
- M. Namazi (2021)
- A. J. Smolka (2015)
- R. K. Oates (2013)
- E. Gammon (2011)
- T. Vimolket (2003)
- W. J. Bicknell (2001)
- F. Abedi (2022)
- R. Goudarzi (2021)
- J. M. Nasirabad (2021)
- A. Rostamzadeh (2022)
- N. Shahraki (2021)
- R. Esmaeili (2018)
- M. T. Gholamhoseini (2019)
- S. Moradi (2018)
- M. Rezaei (2018)
- S. Ghasempour (2016)
- A. A. Haghdoost (2014)
- A. Rajabi (2012)
- J. Kojuri (2010)
- K. Saeid (2007)
- F. Ebadi Azar (2006)
- D. R. Mofid (2006)
- A. Barati (2005)

Legend: ● Adequetly reported, ● Not clearly reported but informaion allows for interpretation, ○ Not applicable, ● Not reported

suggest that the increase in tuition fees and the consequent decrease in scholarships often result from the high cost of medical education at universities (26). For instance, a questionnaire study of first- to fifth-year medical students at the Yong Loo Lin School of Medicine, National University of Singapore, revealed a total tuition fee of S$87,450 for a 5-year medical course (27). Similarly, in Australia, an estimate based on 2015 course fees for domestic, full-fee-paying university students in Victoria found that general medicine graduates were the most expensive to train, costing $451,000 per graduate (28). Notably, these 2 studies, which calculated the cost of medical education from the student and family perspective, were the only studies identified during the screening phase. However, they were excluded from our study because they did not meet the inclusion criteria during the full-text screening phase.

An overarching trend in Iran and other countries is the disproportionately higher cost of training medical students compared with different areas of the medical sciences.

This cost disparity highlights the need for future research to explore the underlying factors driving this disparity. Efforts should be directed toward reducing unnecessary expenditures while maintaining the quality of education. To minimize expenditure while maintaining educational standards, an additional focus should be placed on scrutinizing overhead costs. In particular, since the primary objective of education is to develop skills, in this context, overhead costs add less value than direct training costs.

Limitations
Despite extensive efforts to include a wide range of data sources, such as comprehensive searches of scientific articles, published reports, and gray literature, along with attempts to obtain full texts by contacting corresponding authors when unavailable, there may be inherent limitations in the systematic review process. In addition, university websites can provide valuable information, particularly on tuition fees and other related costs. However, they may not always provide comprehensive data on the pro-

vider's perspective of the cost of education for health and medical students. Moreover, information on university websites may vary in detail, consistency, and methodology, making it difficult to conduct a standardized and thorough comparative analysis. Therefore, information from websites is not included in this study.

Furthermore, comparing historical data from the early 2000s with recent publications is an inherent challenge, given the significant changes in the cost of medical education worldwide. The evolving nature of costs over the past two decades creates complications in directly comparing older studies with more recent findings, which may affect direct comparisons of data across time periods.

Conclusion

This systematic review highlights the significant variation in the per capita cost of medical student education in different countries, with Iran's costs being higher than most countries except the US. The results of this study provide a comprehensive overview of the cost of medical student education and show signficianct differences in the cost of studying medicine at different universities, both in Iran and other countries. Moreover, the cost of medical education was much higher than the cost of education in other fields, and this cost difference was significant in some universities. Most of the studies performed in Iran used the activity-based costing method, which made the studies more comparable. The information derived from the comparison of different studies in this systematic review can be helpful for health care managers and decision makers to optimize the use of resources, save costs, and increase productivity in medical education. In addition to the considerable cost difference between medical education and other fields, the cost variation within the same country highlights a pertinent concern. One way of addressing this issue might be to introduce a degree of uniformity in both cost structures and standards of provision.

Authors Contributions
All authors participated in formulating the concept, executing the implementation, processing the results, and composing the manuscript.

Ethical Approval
Ethical approval is not necessary for this type of study.

Conflict of Interests
The authors declare that they have no competing interests.

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Appendix 1. PRISMA 2020 Checklist

TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 4-5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary file 2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	N/A
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	N/A
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 7
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 4 (Figure 1)
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 7

Appendix 1. PRISMA 2020 Checklist

TITLE				
Study characteristics	17	Cite each included study and present its characteristics.	Page 8-9 (Table 1 & 2)
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary file 3
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 9-10 (Table 3)
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary file 3
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION				
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 11-12
	23b	Discuss any limitations of the evidence included in the review.	Page 12
	23c	Discuss any limitations of the review processes used.	Page 12
	23d	Discuss implications of the results for practice, policy, and future research.	Page 12
OTHER INFORMATION				
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Not registered
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Not prepared
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not registered
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Listed separately
Competing interests	26	Declare any competing interests of review authors.	Listed separately
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Listed separately

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Appendix 2. Search strategies for each database

PubMed
(Cost*[ti] OR Pric*[ti] OR Econom*[ti]) AND (Educat*[tiab] OR Teach*[tiab] OR Training[tiab] OR Curriculum[tiab]) AND ((Student*[tiab] AND Medical[tiab]) OR (Student*[tiab] AND Med[tiab])) AND 2000/01/01 :2022/11/30 [dp]
Result : 290 articles

Scopus
(TITLE (Cost*) OR TITLE (Pric*) OR TITLE (Econom*)) AND (TITLE-ABS (Educat*) OR TITLE-ABS (Teach*) OR TITLE-ABS (Training) OR TITLE-ABS (Curriculum)) AND ((TITLE-ABS (Student*) AND TITLE-ABS (Medical)) OR (TITLE-ABS (Student*) AND TITLE-ABS (Med))) AND (PUBYEAR > 1999 AND PUBYEAR < 2023)
Results: 330 articles

Web of Science
(TI=(Cost*) OR TI=(Pric*) OR TI=(Econom*)) AND (TS=(Educat*) OR TS=(Teach*) OR TS=(Training) OR TS=(Curriculum)) AND ((TS=(Student*) AND TS=(Medical)) OR (TS=(Student*) AND TS=(Med))) AND PY=(2000-2022)
Results: 323 articles

Embase
(Cost*:ti OR Pric*:ti OR Econom*:ti) AND (Educat*:ti,ab OR Teach*:ti,ab OR Training:ti,ab OR Curriculum:ti,ab) AND ((Student*:ti,ab AND Medical:ti,ab) OR (Student*:ti,ab AND Med:ti,ab)) AND [2000-2022]/PY
Results: 393 articles