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Iranian Society of Parasitology
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Review Article

The Current Status of Medical Parasitology in Iran: Developing a Roadmap, Structural Mapping, and Proposed Scenarios for the Future of This Field

*Seyed Mahmoud Sadjadi¹, Mehdi Mohebbi², Iraj Sharifi³, Abdolhossein Dalimi Asl⁴, Ali Haghighi⁵, Abdollah Rafei⁶, Mostafa Rezaeian², Gholamhossein Edrissian², Hossein Keshavarz Valian², Mohammad Bagher Rokni², Mohammad Fallah⁷, Hossein Yousefi Darani⁸, Elham Razmjoo⁹, Mehrzad Saraci¹⁰, Ali Haniloo¹¹, Hossein Hooshyar¹², Ali Ehsan Heidari¹³, Shirzad Gholami¹⁴, Mahmoud Mahami Oskouei¹⁵, Farnaz Kheirandish¹⁶, Tahereh Mohammadzadeh¹⁷, Yosef Sharifi¹

1. Department of Parasitology and Mycology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
2. Department of Parasitology and Mycology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
3. Department of Parasitology and Mycology, School of Medicine, Kerman University of Medical Sciences, Kerman, Iran
4. Department of Parasitology and Entomology, School of Medicine, Tarbiat Modares University, Tehran, Iran
5. Department of Parasitology and Mycology, School of Medicine, Shabid Beheshti University of Medical Sciences, Tehran, Iran
6. Department of Parasitology and Mycology, School of Medicine, Ahvaz University of Medical Sciences, Ahvaz, Iran
7. Department of Parasitology and Mycology, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran
8. Department of Parasitology and Mycology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
9. Department of Parasitology and Mycology, School of Medicine, Iran University of Medical Sciences, Tehran, Iran
10. Department of Parasitology and Mycology, School of Medicine, Qazvin University of Medical Sciences, Qazvin, Iran
11. Department of Parasitology and Mycology, School of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran
12. Department of Parasitology and Mycology, School of Medicine, Kashan University of Medical Sciences, Kashan, Iran
13. Department of Parasitology and Mycology, School of Medicine, Alborz University of Medical Sciences, Karaj, Iran
14. Department of Parasitology, School of Medicine, Mazandaran University of Medical Sciences, Sari, Iran
15. Department of Parasitology and Mycology, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran
16. Department of Parasitology and Mycology, School of Medicine, Lorestan University of Medical Sciences, Khorramabad, Iran
17. Department of Parasitology, School of Medicine, Baqiyatallah University of Medical Sciences, Tehran, Iran

Received 10 Mar 2025

Accepted 11 May 2025

Keywords:

Medical parasitology;
Current situation;
Roadmap;
Future development;
Faculty;
Laboratory equipment;
Education and research;
Iran

*Correspondence Emails:

smsadjadi@tums.ac.ir,
sadjadi316@gmail.com

Abstract

Background: We aimed to review and analyze the status of Medical Parasitology course including current problems and challenges on human resources, infrastructure, research capacities, educational and investigative priorities in Iran, and to develop a roadmap and future development in this field.

Methods: A questionnaire was prepared to obtain information on Medical Parasitology departments in the country followed by field visits in many cases to collect data on the status of the faculty members, laboratory experts, physical spaces, laboratory equipment, microscopic slides, training Parasitology techniques, research projects and theses, published articles and books, access to Parasitology journals, books and e-books during 2022-2023. A roadmap and future development for Medical Parasitology in Iran and the formulation of a desirable status concerning short term to long-term goals was compiled.

Results: While prominent strengths such as capable research laboratories, experienced faculty, suitable educational spaces, active research centers, the existence of centers for keeping and working with laboratory animals, international and national collaborations are seen in a number of medium to large centers, shortcomings related to expert human resources, lack of educational equipment and slides, the need to upgrade especially in practical subjects, journal clubs, and lab meetings, research infrastructure such as laboratory animal houses, budget for theses and research projects urgently need attention. Among 132 universities, faculties, and educational-research centers training personnel in allied medical sciences disciplines, a considerable number lack Parasitology specialists.

Conclusion: Iran has a strong foundation in Medical Parasitology. However, using non-permanent faculty paid per course in medical education undermines quality and strains resources, exacerbating shortages. Universities must implement tailored strategic plans for parasitology, regularly updated to strengthen education, research, and health services, ensuring sustained excellence in training and public health contributions.



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DOI: <https://doi.org/10.18502/ijpa.v20i2.19020>

Introduction

Over the past five decades, Parasitology has evolved significantly through the integration of traditional methods and modern interdisciplinary sciences (1). Innovations in cell and molecular biology, genomics, proteomics, metabolomics, and nanotechnology have transformed parasite diagnosis, classification, transmission studies, epidemiology, immunology, and treatment (2-6). These technologies enable precise identification of parasites, understanding of evolutionary pathways, and development of targeted therapies. Such advancements have reshaped global and regional approaches to parasitic disease management, including in Iran, where classical techniques like microscopy now coexist with cutting-edge methodologies (7-24). Parasitology has deep roots in Iran's academic landscape. The discipline began in 1939 with the establishment of the "Malariology Chair" at Tehran University's Faculty of Medicine. In 1966, the "Department of Medical Parasitology and Mycology" was founded in School of Public Health at the Tehran University. Following the Islamic Revolution (1979), the field expanded across Iranian medical universities (25-27). Initially offering specialized degrees for medical, veterinary, and pharmacy graduates, the academic structure shifted in 1991 to a Ph.D. level program. Today, candidates with master's degrees in related fields or professional degrees in medicine, pharmacy, or veterinary science are eligible for Ph.D. admissions (28-29).

Eleven Iranian universities, including the Universities of Medical Sciences of Tehran, Shahid Beheshti, Iran, Isfahan, Shiraz, Ahvaz, Kerman, Zanjan, Mazandaran, Hamedan, and Tarbiat Modares University, offer Ph.D. programs in Medical Parasitology. While this expansion reflects academic progress, unplanned growth risks straining resources. Strategic evaluations emphasize nine key areas: mission alignment, curriculum quality, research output,

student support, faculty competence, resource allocation (labs, equipment, funding), assessment protocols, administrative structure, and graduate outcomes. Iran's ranking as a regional leader in Parasitology underscores achievements but highlights the need for sustainable development to maintain excellence (4, 26, 27). A critical point requiring attention is that while global health efforts may succeed in eliminating several parasitic and neglected tropical diseases such as dracunculiasis, lymphatic filariasis, onchocerciasis, and human African trypanosomiasis by 2050, urbanization and climate change are expected to drive the spread of helminth infections like schistosomiasis and soil-transmitted helminths in overcrowded, poorly sanitized cities. This will coincide with zoonotic helminthiasis such as toxocariasis, food-borne trematodes, and cysticercosis due to unregulated food systems and closer human-animal interactions. Protozoan diseases, including urban-adapted leishmaniasis, Chagas disease, and malaria, as well as intestinal infections like giardiasis, will persist due to contaminated water and waste, while zoonoses such as toxoplasmosis remain through environmental and animal reservoirs (30). Addressing these challenges will require adaptive surveillance, One Health approaches, and innovations in diagnostics and vaccines (5,16,18,22,24,30). One of the most important key challenges in achieving these objectives include limited funding and financial resources (31). Given these needs, a strategic roadmap for Parasitology must be developed for the future. Creating a structured Parasitology roadmap for Iran requires a thorough understanding of the current state of medical Parasitology in the country, ensuring alignment between local conditions and global standards. Key challenges in this field include human resource training for various roles, infrastructure and research capacity limitations, financial constraints and, educational and research pri-

orities. These issues must be carefully analyzed to develop an effective roadmap, which should outline short-term, medium-term, and long-term goals for progress.

Comparative studies with international models will help tailor strategies to Iran's context. Previous initiatives have provided foundational data (25, 26, 27). However, deeper analysis is needed to formulate actionable scenarios. Plans must integrate education, research, and healthcare services to align with national health goals (28, 29, 31). As the strategic planning is critical to transforming growth into sustained excellence. By addressing resource gaps, fostering interdisciplinary research, and adopting global best practices, Iran can solidify its leadership in the Middle East while contributing to global advancements in parasitology. Collaboration among universities, policymakers, and international partners will be essential to realize this vision, ensuring the field remains relevant in combating parasitic diseases amid evolving scientific and societal demands.

The present study was conducted to develop a roadmap, structural mapping, and proposed scenarios for the future of this field. The findings of this study will guide the planning of education, research, and services at the national level.

Methods

This study was designed and conducted in four parts:

A: A questionnaire was prepared to obtain information on Medical Parasitology departments in the country including the status of the faculty members and their rank, laboratory technical staff status, physical space status, laboratory equipment and facilities, teaching Parasitology techniques, collaboration with educational, research, and treatment centers, research projects and theses, publication of articles and books by group/center/faculty/university members, availability of Parasitology books and e-books

in the library, Internet status, access to online Parasitology journals, student evaluations of the Department/educational section, evaluations by administrators of the Department/educational section, and quantitative and qualitative evaluation of educational slides in the Medical Parasitology Departments across the country were collected for the years 2022-2023. Both field visits and questioners were used for collection of information. Unfortunately, a number of institutions did not respond to the questioners. However, with different reliable sources including Iranian Research Institute for Information Science and Technology (ISID): <https://isid.research.ac.ir/>, the questioners were completed and verified. A part of the questionnaires was completed with the help of the Parasitology Board members and field visits to 27 universities with the financial support of the Committee of Basic Medical Sciences, Health, and Specialization of the Ministry of Health, Treatment, and Medical Education during 2022-2023. The data were transferred to an Excel file sheet and analyzed.

B: Status of Parasitology in Selected Countries.

C: Iran's scientific status in Parasitology according to the published articles was compared globally and within the Middle East.

D: A roadmap and future development plan for Parasitology in Iran were developed. Keeping in mind the model cases from other countries and outlining the desired state based on long-term goals such as providing human resources, facilities, equipment, educational and laboratory spaces, and setting educational and research priorities. This included developing necessary indicators for the field's future and pathways to achieving the desired state.

Results and Discussion

Based on the extracted data, 132 universities/faculties/centers are currently engaged in training human resources in medical, pharma-

ceutical, dental, public health, and paramedical sciences (Figs. 1-2, Table 1). Among these, 65 centers have faculty members specializing in Parasitology (holding a Ph.D. in Parasitology from a reputable university inside or outside Iran) and master's degree holders, ranging from one to 13 individuals. According to the medical education programs approved by the Ministry of Health, faculties training human resources in medicine and related sciences typ-

ically require at least three faculty members in specialized fields such as Medical Parasitology and mycology. According to Figs. 1-2 and Table 1, 39 medical universities and faculties in Iran have three or more specialists in Medical Parasitology, nine universities have two faculty members specializing in Parasitology, and 17 universities/centers have only one specialist in this field.

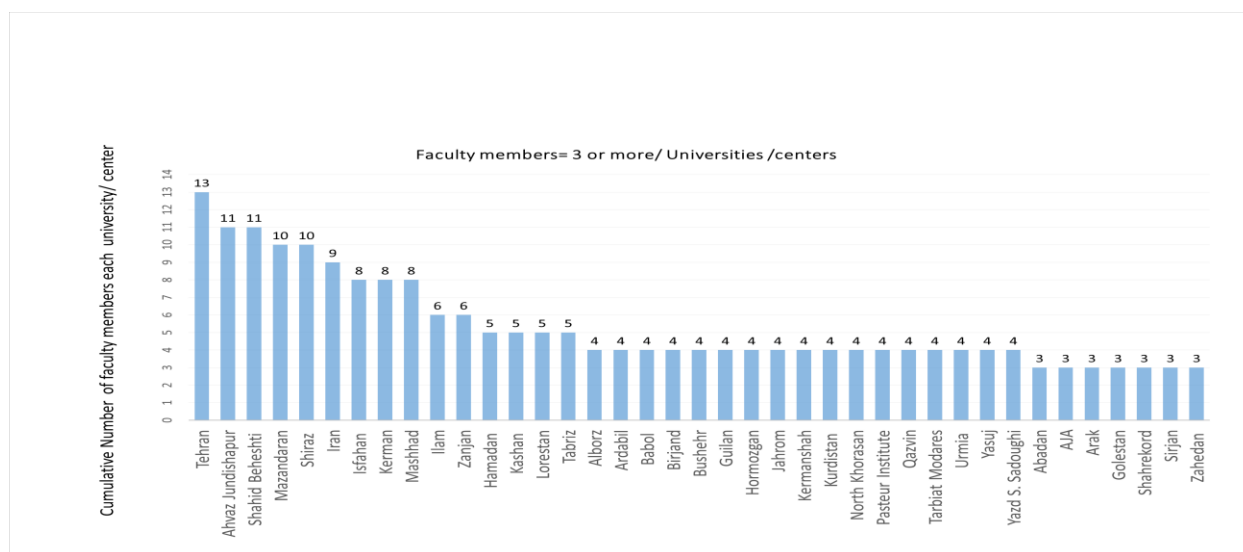


Fig. 1: An overview of the status of Parasitology faculty members in universities of medical sciences and scientific centers across the country in the year 2022-2023, based on the number of faculty members (3 or more than three faculty members per center)

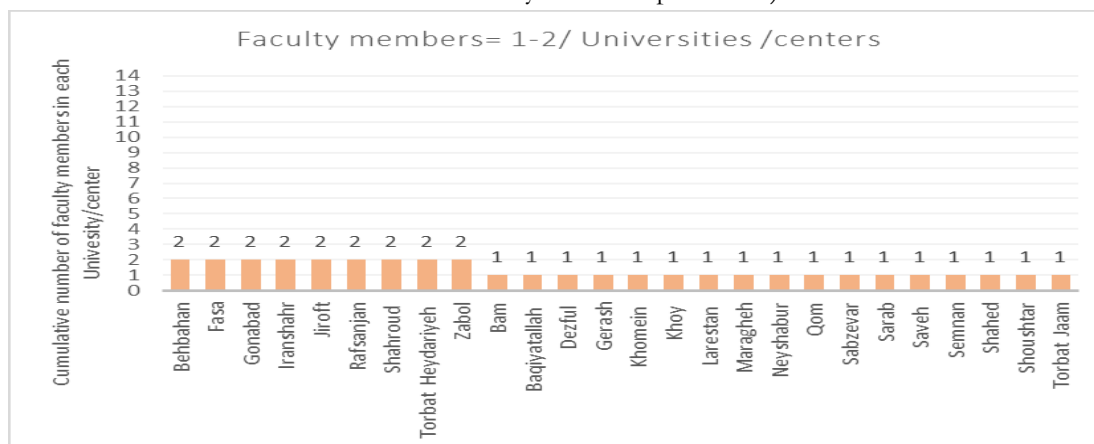


Fig. 2: An overview of the status of Parasitology faculty members in universities of medical sciences and scientific centers across the country in the year 2022-2023, based on the number of faculty members (less than three faculty members per center)

Table 1: The list of University/College/Medical Centers without Parasitology Faculty Members (2023) (N=67)

List No.	Name of U.C.MC	List No.	Name of U.C.MC	List No.	Name of U.C.MC	List No.	Name of U.C.MC
1	Abadeh	18	Chabahar	35	Khomeyni Shahr	52	Moghan
2	Abarkuh	19	Damghan	36	Lamerd	53	Nahavand
3	Abhar	20	Darab	37	Langroud	54	Naqadeh
4	Ahar	21	Daregaz	38	Qaen	55	Ramsar
5	Aligudarz	22	Dehloran	39	Quchan	56	Poldokhtar
6	Amin Police S.	23	Dorud	40	Maneh va Samalqan	57	Ramhormoz
7	Amol	24	Esfarayan	41	Mahabad	58	Salmas
8	Aradan	25	Estahban	42	Mahshahr	59	Sarayan
9	Aran va Bidgol	26	Evaz	43	Malayer	60	Saqquez
10	Asadabad	27	Ferdows	44	Marand	61	Sepidan
11	Bandar Anzali	28	Gonbad-e Kavus	45	Masjed Soleyman	62	Shirvan
12	Bandar Lengeh	29	Islamabad-e Gharb	46	Mamasani	63	Sorkheh
13	Behshahr	30	Izeh	47	Meshginshahr	64	Sonqor
14	Boroujen	31	Jovein	48	Meybod	65	Tabas
15	Borujerd	32	Kashmar	49	Miandoab	66	Zarand
16	Bostan	33	Khalkhal	50	Minab	67	Varamin
17	Bukan	34	Khash	51	Miyaneh		

*U.C.MC= University/College/Medical Centers

Of 132 institutions delivering allied medical sciences education, 67 face critical shortages of Parasitology specialists. A large number of these centers are small and do not have permanent or resident faculty members, and their affairs particularly the teaching of their students are handled by adjunct or non-permanent faculty paid per course, which of course has a significantly negative impact on the quality of their education. For maintenance of the training quality a minimum faculty member as well as infrastructures are required based on the rules approved by the Ministry of Health, Treatment and Medical Education. Every year, a high number of high-potential students are admitted to the high

ranked Universities to be trained in the field of medical sciences including Parasitology in MSc or PhD programs. Although, one of the most important key challenges in training specialist in the field of Parasitology include limited funding and financial resources (31). Training of allied medical sciences students in the centers by non-permanent faculty paid per course is a big challenge for training. The current system of redistributing faculty from established institutions to understaffed centers creates two critical problems: it weakens the teaching capacity of core universities while failing to provide students at non-permanent faculty paid per course centers with stable, high-quality education. This challenge is exac-

erbed by persistent reliance on expensive non-permanent faculty paid per course as significant annual expenditures on temporary instructors institutionalize faculty shortages rather than solving them. Moreover, entrenched patronage networks routinely bypass qualified new graduates for employment, perpetuating a self-defeating cycle that hinders institutional growth and educational equity. The minimum faculty required for training master's degree students is four members, including one professor, one associate professor, and two assistant professors with specializations in Protozoology and Helminthology (Supreme Council of Medical Sciences Planning, approved educational programs for the non-continuous master's degree in Medical Parasitology). Additionally, at least two laboratory technicians specializing in Parasitology (or one laboratory sciences technician and one master's degree holder in Parasitology) are required (28).

For training Ph.D. students in Parasitology, at least five faculty members specializing in Parasitology are required, including two professors and three associate professors with specializations in protozoology and helminthology (Supreme Council of Medical Sciences Planning, approved educational programs for the Ph.D. in Medical Parasitology) (29).

A look at Figs. 1-2 and Table 1, reveal that more than half of the universities/faculties and educational centers training human resources in medical and related sciences lack these minimum requirements. The number of universities/faculties and educational centers without even one parasitologist is alarmingly high, exceeding 60 centers. Analysis of the results in different provinces of Iran shows that between 1 and 46 specialists in Medical Parasitology are employed in various medical universities across the country (Fig. 3).

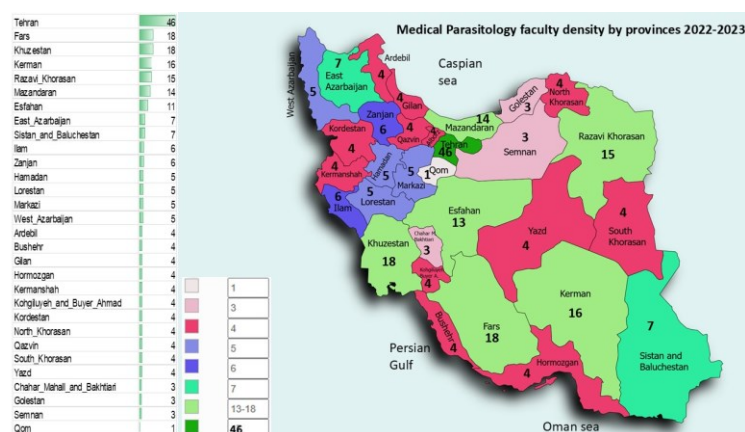


Fig. 3: Map of Iran showing 244 medical parasitologist density by provinces.

A total of 220 educational faculty members and 25 research faculty members are employed in scientific medical centers in Iran. Of these, 228 hold a Ph.D. involving education and teaching Parasitology, 5 hold a Ph.D. in research, and 12 hold a master's degree in Parasitology. There are 70 professors, 52 associate professors, 112 assistant professors, and 11 instructors employed. Out of the 132 cen-

ters, some of which are listed in the university entrance examination booklet as qualified centers for training human resources in various medical sciences, 65 have Parasitology faculty members, while 67 lack Parasitology faculty members (Figs.1-3 and Table 1). Fig. 1-3 illustrate faculty distributions across universities, faculties, and educational centers. However, this is not a fixed and unchangeable issue and

may be affected and reduced by various factors such as retirement, disability, death, migration, or lack of academic progress and expulsion from the university. Therefore, continuous monitoring and evaluation of this matter should be one of the key responsibilities of educational policymakers.

It is critical to highlight those certain institutions with more faculty members as has been shown in the figure 1, only eligible faculty members are involved in postgraduate teaching and research roles. For example, Shiraz University of Medical Sciences lists 7 faculty members in the Department of Parasitology and Mycology (School of Medicine) actively engaged in MSc and PhD programs, while Fig. 1 reports 10. This indicates that 3 faculty members are exclusively dedicated to undergraduate instruction or non-postgraduate research activities. Similar discrepancies exist in larger institutions, including Tehran, Shahid Beheshti, Iran, Mazandaran, Ahvaz, and Kerman Universities of Medical Sciences. (Comprehensive details of these information has been reflected in a report in Persian language submitted to the Ministry of Health, Treatment and Medical Education as: Mapping the current situation of medical Parasitology in the country and developing a roadmap and future development of the field in the country, including analyzing the current situation of the field, structural and functional mapping, comparison with model cases, developing possible scenarios for the future and forecasting the desired situation (Sadjjadi et al., 2023: Unpublished document). These variations carry critical implications for strategic planning, particularly in resource distribution. Furthermore, faculty compositions within departments are dynamic and subject to change due to many items including the retirement of faculty members, requiring ongoing monitoring to maintain alignment with institutional objectives and effective allocation of resources. The presence of faculty members in various centers, large and small, that train human re-

sources in medical sciences [some of them are listed in the university entrance examination booklet as qualified centers for training human resources in various fields of medical sciences] listed as lack of Parasitology faculty members, is significant. Improving education, in addition to faculty, requires other strategies, including continuous monitoring and evaluation.

The results of the analysis of the status of laboratory technicians, physical space, laboratory equipment, teaching Parasitology techniques, collaboration with educational and medical centers, research projects and theses, published articles and books, availability of Parasitology books and e-books accessible to faculty members, staff and students, internet access, access to online Parasitology journals, student evaluations of the Department/educational section, administrator evaluations of the Department/educational section, and quantitative and qualitative evaluation of educational microscopic slides for 27 universities/faculties/centers which are responsible for training PhD and MSc students are presented in Tables 2 to 3. Each table highlights strengths and weaknesses. These results are a summary of the external evaluation (accreditation) conducted in 2023 across all Parasitology units, including Departments of Parasitology, Parasitology and mycology, and Parasitology and entomology, in medical universities across the country. While notable strengths such as well-equipped research laboratories, experienced faculty, suitable educational spaces, active research centers, facilities for maintaining and working with laboratory animals, and excellent national and international collaborations are observed in many medium to large centers which have been reflected in different papers(7-25), the main shortcomings include a lack of skilled laboratory technicians, insufficient educational tools and microscopic slides, the need for improvement in practical training, journal clubs, lab meetings, research projects and theses.

Table 2: Status of Faculty Adequacy, Technical Staff Adequacy, Physical Space, Laboratory Equipment, Teaching Parasitology Techniques, and Quantitative and Qualitative Evaluation of Educational Microscopic Slides in Universities Offering Master's and Ph.D. Programs in 2023

University of Medical Sciences	Faculty Adequacy	Technical Staff Adequacy	Physical Space	Laboratory Equipment	Teaching Parasitology Techniques	Evaluation of Microscopic Slides
Ahvaz	1	1	3	1	1	1
Alborz	1	2	1	1	1	1
Bandar Abbas	2	1	2	1	1	2
Baqiyatallah	2	2	1	1	1	1
Gilan	2	2	2	1	1	1
Hamedan	2	2	2	1	1	1
Ilam	1	1	1	1	1	1
Iran	1	1	1	1	1	1
Isfahan	1	1	2	1	1	4
Jahrom	1	2	1	1	1	2
Kashan	1	2	2	1	2	2
Kerman	2	1	1	1	1	1
Lorestan	1	2	2	1	1	1
Mashhad	1	1	1	1	1	1
Mazandaran	1	2	2	3	1	3
Qazvin	2	2	1	1	1	1
Shahid Beheshti	1	2	1	1	1	1
Shahrekord	2	1	1	1	1	2
Shiraz	1	1	1	1	1	1
Tabriz	1	2	2	1	1	1
Tarbiat Modares	1	1	1	1	1	1
Tehran	1	1	1	1	1	1
Urmia	1	1	1	1	1	1
Yazd	1	1	2	1	1	1
Zabol	2	2	2	2	1	2
Zahedan	2	1	2	2	1	2
Zanjan	1	1	3	1	1	1

Key: 1=Adequate, 2= Inadequate, 3=Adequate for Master's, Inadequate for Ph.D., 4=Inadequate for Master's, Adequate for Ph.D

Table 3: Status of Collaboration with Educational and Medical Centers, Research Projects and Theses, Published Articles and Books, Availability of Parasitology Books and E-books, Internet Access, Access to Online Parasitology Journals, Student Evaluations of the Department/Educational Section, and Administrator Evaluations of the Department/Educational Section in 2023

Univer- sity of Medical Sciences	Collabora- tion with Educa- tional and Medical Centers	Re- search Pro- jects and Theses	Pub- lished Articles and Books	Availabil- ity of Parasit- ology Books and E- books	Inter- net Ac- cess	Access to Online Parasit- ology Journals	Student Evalua- tions	Adminis- trator Evalua- tions
Ahvaz	1	1	1	1	2	2	1	1
Alborz	1	1	1	1	1	1	1	1
Bandar Abbas	1	1	1	1	1	1	1	1
Baqiyatal- lah	1	1	1	1	1	1	1	1
Gilan	1	1	1	1	2	2	1	1
Hamedan	2	1	1	1	2	2	1	1
Ilam	1	1	1	1	1	1	1	1
Iran	1	1	1	1	1	1	1	1
Isfahan	3	1	1	3	1	3	1	1
Jahrom	1	1	1	1	2	1	1	1
Kashan	2	1	1	1	1	1	1	1
Kerman	1	1	1	1	1	1	1	1
Lorestan	2	1	1	2	2	2	1	1
Mashhad	1	1	1	1	1	1	1	1
Ma- zandaran	1	1	1	1	1	1	2	1
Qazvin	1	2	1	1	2	2	1	1
Shahid Beheshti	1	1	1	1	1	1	1	1
Shahreko rd	1	2	1	1	1	1	1	1
Shiraz	1	1	1	1	1	1	1	1
Tabriz	1	2	1	1	1	1	1	1
Tarbiat Modares	1	1	1	1	1	1	1	1
Tehran	1	1	1	1	1	1	1	1
Urmia	2	2	1	1	1	1	2	1
Yazd	1	1	1	1	1	1	1	1
Zabol	2	2	1	1	1	1	2	1
Zahedan	2	2	1	1	1	1	2	1
Zanjan	1	1	1	1	1	1	1	1

Key: 1=Adequate, 2= Inadequate, 3=Adequate for Master's, Inadequate for Ph.D., 4=Inadequate for Master's, Ade-
quate for Ph.D

Status of Parasitology in Selected Countries

To use the standards of the world, the status of Parasitology in selected countries from the world were reviewed, and Iran's scientific status in Parasitology was compared globally and within the Middle East (Sadjjadi et al, Unpublished document, 32-37). However, it should be mentioned that, economic sanctions may adversely affect health and healthcare systems, including medical education and training (38-39).

The Position of Parasitology in Iran

The position of Parasitology in Iran compared to other countries according to number of published articles and their impact degree

in the world is presented in Tables 4 to 7 As has been shown, during the period from 1996 to 2022, Iran's overall rank is 16th, and if we consider the year 2022, Iran's rank is 9th. If we consider Middle Eastern countries, Iran's rank is the first in terms of quantity of published articles (40). While progress in scientific paper output has been positive, there are shortcomings in research quality, particularly evident in the impact of these publications. Another issue is self-citation, which warrants separate and thorough examination. It should be scrutinized in detail. Looking at the relevant tables, we see that more efforts are needed in terms of the quality of research and articles. (40, 41).

Table 4: Position of Parasitology in Iran Compared to Other Countries in the World from 1996 to 2022 (Top 25 Countries) (Scimago) According to the Number of Articles

Rank	Country	Region	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	United States	Northern America	51275	49972	1940758	878881	37.85	323
2	United Kingdom	Western Europe	20174	19482	737519	191495	36.56	234
3	Brazil	Latin America	17179	16660	311626	146338	18.14	141
4	China	Asiatic Region	13696	13418	210626	89727	15.38	141
5	France	Western Europe	11332	11052	357030	72925	31.51	182
6	Germany	Western Europe	9180	8985	343682	67509	37.44	190
7	Australia	Pacific Region	8128	7878	274693	59213	33.8	176
8	India	Asiatic Region	7478	7203	130936	49346	17.51	108
9	Japan	Asiatic Region	6415	6336	171934	32562	26.8	141
10	Spain	Western Europe	5638	5533	147781	34650	26.21	124
11	Switzerland	Western Europe	5542	5343	228223	35018	41.18	173
12	Italy	Western Europe	5217	5037	168123	35664	32.23	148
13	Canada	Northern America	5134	5002	198657	29751	38.69	165
14	Netherlands	Western Europe	4115	3999	163049	21393	39.62	154
15	Thailand	Asiatic Region	4054	3971	106522	25999	26.28	125
16	Iran	Middle East	3837	3775	54175	26313	14.12	69
17	Mexico	Latin America	3369	3326	62723	18558	18.62	90
18	Belgium	Western Europe	3305	3189	104948	15391	31.75	121
19	Argentina	Latin America	3239	3206	61242	17907	18.91	85
20	South Africa	Africa	3150	3057	79443	15885	25.22	111
21	South Korea	Asiatic Region	3009	2979	59811	12401	19.88	90
22	Kenya	Africa	2877	2841	98539	19715	34.25	126
23	Czech Republic	Eastern Europe	2865	2807	54552	14104	19.04	82
24	Sweden	Western Europe	2525	2470	103260	12316	40.9	124
25	Egypt	Africa/Middle East	2431	2410	39858	8525	16.4	73

Table 5: Position of Parasitology in Iran in the World in 2022 (Top 25 Countries) (Scimago) According to the Number of Articles

Rank	Country	Region	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	United States	Northern America	1956	1849	1950	886	1	323
2	China	Asiatic Region	1416	1378	1381	786	0.98	141
3	Brazil	Latin America	887	840	487	234	0.55	141
4	United Kingdom	Western Europe	716	691	726	201	1.01	234
5	India	Asiatic Region	429	409	257	94	0.6	108
6	Germany	Western Europe	387	371	506	121	1.31	190
7	France	Western Europe	335	320	303	86	0.9	182
8	Australia	Pacific Region	326	316	321	95	0.98	176
9	Iran	Middle East	307	303	180	69	0.59	69
10	Spain	Western Europe	275	266	255	66	0.93	124
11	Japan	Asiatic Region	251	234	168	46	0.67	141
12	Italy	Western Europe	230	219	277	89	1.2	148
13	Canada	Northern America	218	211	295	47	1.35	165
14	Thailand	Asiatic Region	209	205	202	63	0.97	125
15	Switzerland	Western Europe	204	199	227	38	1.11	173
16	South Africa	Africa	199	192	235	61	1.18	111
17	Egypt	Africa/Middle East	194	192	123	49	0.63	73
18	Turkey	Middle East	175	142	56	18	0.32	57
19	Mexico	Latin America	171	170	93	26	0.54	90
20	Malaysia	Asiatic Region	148	142	95	27	0.64	68
21	Peru	Latin America	141	137	36	17	0.26	67
22	Ethiopia	Africa	140	139	78	31	0.56	66
23	Argentina	Latin America	137	136	82	12	0.6	85
24	Netherlands	Western Europe	134	129	174	27	1.3	154
25	Nigeria	Africa	127	126	63	18	0.5	63

Table 6: First to 3rd Position of Parasitology of the countries in the Middle East from 1996 to 2022 (Scimago) According to the Number of Articles

Rank	Country	Region	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	Iran	Middle East	3837	3775	54175	26313	14.12	69
2	Egypt	Africa/Middle East	2431	2410	39858	8525	16.4	73
3	Turkey	Middle East	1674	1587	22606	5758	13.5	57

Table 7: First to 3rd Position of Parasitology of the countries in the Middle East in 2022 (Scimago) According to the Number of Articles

Rank	Country	Region	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	Iran	Middle East	307	303	180	69	0.59	69
2	Egypt	Africa/Middle East	194	192	123	49	0.63	73
3	Turkey	Middle East	175	142	56	18	0.32	57

Roadmap and Future Development of Parasitology in Iran

The roadmap and future development of Parasitology in Iran, compared with model cases and, the formulation of an ideal state based on long-term goals such as providing human resources, facilities, equipment, educational and laboratory spaces, and, determining educational and research priorities to develop necessary indicators for the field in the future and ways to achieve the desired state were formulated. For better strategic planning a total of 21 points and recommendations have been categorized in to short-term (STG: 1–2 years), medium-term (MTG: 3–5 years), and long-term goals (LTG: 5+ years) based on feasibility, urgency, and complexity as follows:

Short-term goals (STG: 1–2 years),

1. Centers with insufficient faculty should recruit qualified faculty members according to existing regulations.

2. Medical universities should employ Parasitology Master's holders as lab technicians to strengthen educational and research capabilities in specialized departments.

3. Examining the research conducted on parasitic diseases in Iran shows that there are still lots of shortcomings needed further research, but for some economic reasons and some due to the difficulty of the work, they still lack applicants. Therefore, creating specific grants for the prevention, control, diagnosis, and treatment of endemic parasitic diseases should be prioritized.

4. Some zoonotic parasitic diseases such as echinococcosis, toxocariasis, toxoplasmosis, and leishmaniasis are increasing day by day due to some habits and behaviors in society and extensive climatic changes in recent years, and it is necessary to prepare appropriate guidelines for each and review them at least every two years so that parasitologists and

others can take timely action for their prevention, control, diagnosis, and treatment.

5. Continuous assessment of students is a fundamental requirement for academic progress. As a key principle in educational systems, continuous assessment plays a vital role in enhancing students' academic and skill-based development in many courses including Parasitology (42). This approach goes beyond a single final examination and includes diverse methods such as projects, class participation, quizzes, presentations, and periodic feedback.

6. Strengthening domestic Parasitology journals and proper citation of research presented in them, as seen in the countries at the top of the list of the most successful countries in Parasitology research, is essential.

7. Joint classes between university centers in the country in an online environment can also be a significant help in improving educational conditions given the lack of resources.

Medium-term goals (MTG: 3–5 years):

8. Centers lacking faculty, numbering are over 60, should have at least one parasitologist within a period of one to two years.

9. Each medical university should develop a tailored strategic plan for Parasitology, taking into account the specific challenges and needs of its respective region or province.

10. The experience of successful countries and having reference centers for diagnosing specific parasitic diseases, which sometimes give incorrect diagnoses due to a lack of precision and the non-use of specialized personnel, can be helpful. The experience of some countries in this regard, such as the Liverpool School of Tropical Medicine in the UK with its specialized section for strongyloidiasis studies, the reference laboratory for toxocariasis diagnosis in Slovakia, or the malaria reference center in New Delhi, India, are examples where a reference center with skilled personnel and appropriate facilities has been pre-

pared for each important and endemic parasitic disease to make more accurate diagnoses.

It is worth noting that currently, many microscopic diagnoses of parasites such as amoebae are lost or, in other words, missed in our country and countries with this deficiency, and in some cases, laboratory errors in leishmaniasis samples sometimes reach about 40% (43).

11. In the field of research, in recent years, for various reasons, including the presence of medical universities in provincial centers, significant quantitative progress has been made, and Iran's rank in this field has risen according to the presented tables and charts. However, in terms of quality, this issue has much capacity for growth. Therefore, emphasis on research on endemic diseases and problem-solving within the framework of epidemiological, diagnostic, and therapeutic studies is inevitable. In the field of protozoa: malaria, cutaneous and visceral leishmaniasis, amoebiasis, giardiasis, trichomoniasis, and coccidiosis, especially toxoplasmosis and microsporidiosis, as well as some emerging infectious parasitic diseases such as cyclosporidiosis and microsporidiosis and co-infections of visceral leishmaniasis in HIV-positive patients should be prioritized, and in the field of helminthic diseases, cystic echinococcosis/hydatidosis, fascioliasis, visceral larval migrans, strongyloidiasis, and anisakiasis should be prioritized.

12. Special attention should be paid to emerging diseases such as anisakiasis and filariasis, which are considered obstacles to global sustainable development so that issues related to their diagnosis do not fall into an ambiguous cycle and patients are not left wandering. In addition, considering the presence of transplant Departments in some scientific research centers, special attention must be given to transplantation-associated parasitic infections such as strongyloidiasis and toxoplasmosis, in donors or recipients before transplantation using scientific methods.

13. The necessity of inter-sectoral cooperation for controlling parasitic diseases, especially zoonotic and vector-borne ones, in the country.

14. To train skilled personnel for diagnosis and treatment, adequate educational facilities and resources must be provided. The establishment of knowledge-based companies that can desirably prepare educational aids using graduates of master's and Ph.D. programs in Parasitology and other fields, even technical ones, should be prioritized.

Long-term goals (LTG: 5+ years):

15. Since one of the most important components of growth is having competent personnel in each field, strategic decisions must be made concerning training centers that prepare personnel for diagnostic and treatment facilities to ensure workforce competency without specialized faculty in Parasitology and to employ qualified graduates with a coherent plan.

16. Since each country faces various types of parasites depending on its climatic conditions, specific programs related to etiology, pathogenesis, epidemiology, diagnosis, treatment, and control must be prepared for each, and the economic capacity for each of these tasks requires specific conditions. Therefore, considering Iran's climatic conditions, the dominant types of parasites should be identified, and a puzzle based on land planning should be drawn so that education and research are shaped accordingly. This puzzle should be reviewed annually, its strengths should be strengthened, and weaknesses or unnecessary points should be eliminated.

17. Given the country's population, the distances between cities and villages, their distribution in the homeland, and the economic capacity of each region, It is crucial to establish robust prevention protocols, control, and diagnosis using the maximum scientific capacity of parasitologists in the country. Therefore, the presence of graduates of master's and

Ph.D. programs in Medical Parasitology, in addition to the educational system, in diagnostic systems significantly improves the quality of diagnostic services.

18. Despite good research progress in the field of parasitic diseases in the country and the quantitative ranking of research articles in the world and the Middle East, the position of this field in terms of quality still has the capacity for improvement (Tables 4-7). Additional consideration should be given to innovation in research especially on the One Health and solving local problems related to parasites related to zoonosis and food.

19. Considering the position of Parasitology in Iran, it is recommended to establish programs for training parasitologists from neighboring or regional countries.

20. Since each country faces various types of parasites depending on its climatic conditions, specific programs related to etiology, pathogenesis, epidemiology, diagnosis, treatment, and control must be prepared for each, and the economic capacity for each of these tasks requires specific conditions. Therefore, considering Iran's climatic conditions, the dominant types of parasites should be identified, and a puzzle based on land planning should be drawn so that education and research are shaped accordingly. This puzzle should be reviewed annually, its strengths should be strengthened, and weaknesses or unnecessary points should be eliminated.

21. Given the nature of parasitic diseases, the development of inter-sectoral cooperation for the diagnosis, treatment, and control of these diseases should be emphasized. In this regard, employing these graduates in diagnostic laboratories, especially in educational and large university hospitals to ensure accurate patient care, substantial improvements in diagnostic quality are non-negotiable. Therefore, in hospitals with strong educational aspects and more than 500 daily visitors, categorizing different sections of hospital diagnostic laboratories and assigning the responsibility of Par-

asitology diagnosis to a parasitologist is unavoidable.

Strengths and limitations

This mixed-methods study combined questionnaires and field visits to comprehensively assess Iran's Medical Parasitology status in 132 institutions under the supervision of the Ministry of Health, Treatment and Medical Education. It evaluated key areas such as human resources, infrastructure, research capacity, and education; revealing strong foundations including advanced labs, expert faculty, active research centers, and international collaborations. The developed roadmap provides practical strategies for future improvement.

Self-reported data in a few institutions/centers may not reflect actual conditions. So, more field visits are needed. Roadmap implementation may face financial/administrative barriers. More global assessment and comparison of Iran's Parasitology status with world institutions will help to reach more ideal status.

Conclusion

Despite notable strengths such as experienced faculty, well-equipped research laboratories, suitable educational spaces, active research centers, laboratory animal facilities, and national and international collaborations observed in many large to medium centers, and high scientific ranking among regional countries; there are still shortcomings related to human resources, especially considering factors related to land planning. Out of 132 universities/faculties/educational centers engaged in training human resources in medical sciences, about half (67 centers) although small centers are lacking even one specialist in Medical Parasitology. To maintain standards, resident faculty presence becomes unavoidable across all categories of educational centers. To meet sustainable development goals encompassing

human resources, educational-research facilities, and equipment; each medical university should establish a tailored strategic plan for Parasitology to ensure the quality of education and research is maintained.

Acknowledgements

This project was financially supported by the National Center for Strategic Research in Medical Education, Tehran, Iran, with project number 992087.

Conflict of Interest

The authors declare that there is no conflict of interests.

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