

# MEDICAL PHYSICS EDUCATION, TRAINING AND REGULATION IN JORDAN

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**Abstract—** Cancer is a major problem in Jordan and is the second leading cause of deaths in the country. Successful cancer treatment involves an advanced team that consists of oncologists, medical physicists, dosimetrists, and others. Medical physicists play a pivotal role in the accurate diagnosis and treatment of cancer. Over the last twenty years, medical physics in Jordan has seen an expansion in academic programs which include clinical training in the fields of medical imaging, nuclear medicine, and radiotherapy. This was accompanied by expansion in medical centers for cancer treatment with state-of-the-art diagnostic and treatment equipment. Medical physics education is currently offered through one BSc. program in biomedical physics and two MSc. programs in medical physics. The recognition of Medical Physics as a profession with proper licensing and certification is still a work in progress but there is an optimistic hope of accomplishing this in the near future.

**Keywords—** Medical Physics, Education, Radiotherapy, Nuclear Medicine, Jordan.

## I. INTRODUCTION

Jordan is a Middle Eastern country which is classified as an upper middle-income country (UMIC) by the World Bank classification [1]. The country though has limited resources and faces some economic challenges. It occupies an area of 89,000 km<sup>2</sup> with an estimated population of 10 million in 2018 [2]. Cancer is a major problem in Jordan and is the second leading cause of death, after cardiovascular disease [3]. The number of cancer cases in Jordan has risen from 8,400 in 2015, according to Jordan Cancer registry (JCR) [4], to 11,559 in 2020, according to the Global Cancer Observatory (GCO) [5]. This is an increase of about 5.3% per year which is almost twice the average annual population growth rate (~2.5%) during the same period [2]. Globally, in middle-income countries, it has been estimated that the number of cancer incidents would rise by 80% from 2012 to 2035 (3.5% per year) [6]. Thus, the cases in Jordan seem to follow this trend and are expected to increase in the future. Moreover, the World Health Organization stated that in 2020, cancer will cause the death of more than 10 million people annually around the world [7]. The organization has also warned that some countries do not have any infrastructure for cancer treatment at all, some have the infrastructure but without systems that enable them to provide comprehensive cancer care, and some lack the human resources and knowledge to provide effective treatment.

There is a lack of knowledge with regard to the importance of radiotherapy treatment of cancer in middle-income countries, and thus, medical physics. Radiotherapy now plays a vital role in providing effective cancer treatment. It was estimated that about 6.5 million new cases of cancer in middle-income countries would benefit from radiotherapy at least once during their illness [8]. Despite these facts, studies have shown that developing countries have not benefited from this type of treatment to the same level as Western Europe and North America. The challenge facing developing countries is to establish the required infrastructure, acquire equipment, attract highly qualified professionals, develop education and training programs and adopt policies to provide effective and accessible care for all [9]. These are the challenges that Jordan is currently facing.

The feasibility of medical physics as a unique discipline in Jordan began when a private university (Applied Science Private University) started offering a BSc. Degree in medical physics in 1992. However, that program was not sustained due to string constraints imposed by the Ministry of Higher Education in Jordan that were placed on the acceptance policy of new students and was later terminated. A new attempt to offer a BSc. program in medical physics started at another private university in 1994 (Zarqa Private University) which lasted longer but again that program was not maintained due to similar reasons and was terminated almost 10 years later. It was not until 2004 that a public university, Yarmouk University (YU), started a BSc. program in biomedical physics which attracted students and qualified faculty members. The BSc. Program at YU is still active and strong 17 years later and additionally there are currently two graduate programs offering MSc. degrees in medical physics and a residency program is expected to start very soon in Jordan. This seemed to start a new era for medical physics in Jordan and medical physics started to attract the attention of the public. Furthermore, in 2006, the Jordanian Association for Physicists in Medicine (JAPM) was established with efforts from the limited number of medical physicists working in government agencies, hospitals, and of course academia with leading faculty members from YU University. Currently the society has almost 80 registered and active members. Consequently, the number of centers offering radiotherapy treatments and medical imaging equipment which require medical physicists have expanded during this time as well.

However, despite these improvements, challenges facing medical physicists remain, particularly with professional recognition and certification. The paper will present the infrastructure currently available in the medical physics field, the educational and training programs as well as the current regulations regarding medical physics in Jordan.

## II. INFRASTRUCTURE

The facilities available for training of medical physicists in Jordan are those that have medical diagnostic tools and provide cancer treatment. Currently, there are five centers that have radiotherapy units in Jordan. These are Al Basheer Hospital, King Hussein Cancer Center (KHCC), Al-Afia Radiotherapy and Nuclear Medicine Center, Queen Alia Hospital, and King Abdullah University Hospital (KAUH). In addition, Ibn Al Haytham Hospital has within it a gamma knife center which is a private center offering specialized multi-beam teletherapy. It is worth noting that the KHCC is considered the premier cancer treatment center in Jordan and it attracts the top medical physicists in the country and that the center at KAUH has just started recently in late 2020. The typical treatment techniques and other technical information regarding these centers are listed in Table 1 [10].

Table 1 List of the centers that have radiotherapy units in Jordan, along with the sector, starting date, main treatment techniques and the number of available medical physics [10]

| Institution     | Starting Date | Treatment Technique    | Brachy-therapy System | Medical Physicists | Nuclear Medicine |
|-----------------|---------------|------------------------|-----------------------|--------------------|------------------|
| Al Basheer KHCC | 1987          | 3D CRT                 | No                    | 4                  | Yes              |
|                 | 1997          | 3D CRT<br>IMRT<br>VMAT | HDR<br>LDR            | 14                 | Yes              |
| Al-Afia         | 2006          | 3D CRT<br>IMRT         | No                    | 3                  | Yes              |
| Queen Alia KAUH | 2012<br>2020  | 3D CRT<br>3D CRT       | HDR<br>HDR            | 9<br>4             | Yes<br>Yes       |

For medical imaging and nuclear medicine units, there are currently 11 nuclear medicine centers and many medical imaging units available throughout public and private hospitals and centers. Table 2 shows a list of an estimate number of these units from a recent survey [11]. The table also compares the status of Jordan with its peers in Upper Middle-Income Countries (UMIC) and with the High-Income Countries (HIC) [12].

As can be seen from Table 2, Jordan has made good progress in keeping pace with upper middle-income countries, however, the gap with the high-income countries is still very wide

Table 2: Number of radiology equipment available in Jordan as reported in a recent survey [11] and the amount of equipment per 1 million as reported by the IMAGINE project [12] and compared to UMIC and HIC.

| Unit         | No. in Jordan | No. in Jordan per 1 mil | No. in UMIC per 1 mil | No. in HIC per 1 mil |
|--------------|---------------|-------------------------|-----------------------|----------------------|
| CT scanner   | 100           | 10-15                   | 11.99                 | 37.77                |
| MRI units    | 55            | 5-7.5                   | 5.36                  | 26.53                |
| PET          | 9             | 0-1                     | 0.30                  | 3.52                 |
| SPECT        | 1             | 0-2.5                   | 1.57                  | 17.65                |
| Mammography  | >50           | 0-5                     | 5                     | 30                   |
| Fluoroscopy  | 60            | -                       | -                     | -                    |
| Ultrasound   | 600           | -                       | -                     | -                    |
| Gamma Camera | 15            | -                       | -                     | -                    |
| Gamma knife  | 2             | -                       | -                     | -                    |

## III. EDUCATIONAL PROGRAMS AND TRAINING

At the undergraduate level, there is currently one active program in Jordan offering a BSc. degree in Biomedical Physics. The program is offered by the physics department at Yarmouk University (YU), Irbid. The program offers students advanced senior-level courses in radiation physics, radiobiology, health physics, medical imaging, and radiotherapy. In addition, the students are required to spend 12 weeks of practical training in a hospital as part of the graduation requirements (2 full days of training per week). The training is paid for by YU and available at King Abdullah University Hospital (KAUH). The students also have the option to train at other facilities with the approval of the department but in that case, they must cover their own cost. The program started in 2004 and has graduated almost 600 students since its inception. Currently, the graduates of the YU program make up most of the workforce in radiotherapy, radiation protection and nuclear medicine in Jordan. Many have also gone to neighboring countries to seek job opportunities and others have entered the education sector in the country.

At the graduate level, there are two programs offering a MSc. Degree in medical physics. The first one started in 2007 by the University of Jordan in Amman and is a non-thesis program. The program offers two credit-hours of training at local hospitals. The other program offering a MSc. Degree recently started in 2020 at Yarmouk University in collaboration with the King Hussein Cancer Center. This program offers both a thesis and non-thesis track which are technically research-based and clinical-based tracks respectively. The non-thesis track at YU requires the students to go through clinical training for a full semester (4 months) as full-time trainees which is worth 9 credit hours (36 hours per week). The training will be made available at KHCC as part of the agreement between YU and KHCC. All of the above-mentioned programs are accredited locally by the Jordanian Accreditation and Quality Assurance Commission for Higher Education Institutions (AQACHEI), as required by law. This means that the programs must have a curriculum which provides the students with the

competencies required by the AQACHEI. They include competencies in radiation physics, radiotherapy, radiobiology, and medical imaging. We should add that neither of the graduate programs is accredited by an international accreditation body although both have a curriculum that fulfill the IAEA guidelines [13]. Table 3 provides a list of the academic programs and related information.

Table 3 List of the available academic medical physics programs in Jordan and their related information.

| Program                              | BSc.              |                   | MSc.                  |  |
|--------------------------------------|-------------------|-------------------|-----------------------|--|
|                                      | YU                | JU                | YU                    |  |
| University                           | YU                | JU                | YU                    |  |
| Starting year                        | 2004              | 2007              | 2020                  |  |
| Department                           | Physics           | Physics           | Physics               |  |
| Track                                | -                 | Non-Thesis        | Thesis,<br>Non-thesis |  |
| Faculty members<br>(medical physics) | 6                 | 3                 | 6                     |  |
| Training                             | 3 credit<br>hours | 2 credit<br>hours | 9 credit<br>hours     |  |
| Annual enrollment                    | 50-80             | 10-12             | 10-12                 |  |
| Accreditation                        | Local             | Local             | local                 |  |

YU: Yarmouk University, Irbid.  
 JU: University of Jordan, Amman

It is worth mentioning here that a residency program is expected to start very soon at KHCC in collaboration with YU and IAEA. In addition to the clinical training offered through the BSc and MSc programs, many independent centers offer additional training for a limited number of qualified candidates, mostly in nuclear medicine.

#### IV. REGULATIONS

Regulations of medical physics in Jordan is not fully developed. The educational programs, by law, follow the regulations of the Ministry of Higher Education and Scientific Research (MHESR) and The Jordanian Accreditation and Quality Assurance Commission for Higher Education Institutions (AQACHEI). All the educational programs mentioned earlier are accredited by AQACHEI. On the other hand, monitoring of various facilities that use radiation equipment has gone through various changes in the past few years as part of the country's effort to reorganize its nuclear and atomic agencies. In 2008, the Jordan Nuclear Regulatory Commission (JNRC) was established as a successor to the Nuclear Safety and Radiation Protection Department. Recently, in 2014, a new law was issued to merge the Jordan Nuclear Regulatory Commission, the regulatory activities of the Natural Resources Authority and Electricity Regulatory Commission and is now the Energy and Minerals Regulatory Commission (EMRC). By the new law, EMRC is the body responsible for regulating the use of nuclear energy and ionizing radiation in Jordan. Its responsibilities include:

- Ensuring the availability of the radiation protection requirements for x-ray, radiotherapy, or nuclear medicine departments.
- Authorization of permits and licenses for institutions and workers in the field in compliance with pertinent rules and regulations.
- Controlling and monitoring the implementation of pertinent rules through inspection.

While the role of EMRC includes the licensing of workers in radiation, it is not responsible for certification of medical physicists in Jordan. The Ministry of Health is yet to play a major role in regulating and recognizing medical physics as a profession and it does not play any role in establishing board exams or certificates for the profession as it does with other allied health. The role of the Jordanian Association for Physicists in Medicine (JAPM) has been to try to moderate efforts to regulate the profession by communicating with the different parties involved in recognizing medical physics as a profession. There has been some progress in this regard which includes:

- A radiation officer is now recognized and is required in hospitals that have facilities using ionizing radiation, as required by MERC regulations.
- The Civil Service Bureau (CSB) now recognizes job calls for medical physicists, when requested by public sectors and administers competitive exams for applicant's selection.

Despite these improvements, much still needs to be done in order to achieve full recognition of the profession. Particularly, the Ministry of Health must have a specific body responsible for recognizing the medical physics profession. We are optimistically hoping that in the next few years, a full recognition and regulation of the profession in Jordan will be achieved.

#### V. CONCLUSIONS

In recent years, Jordan has seen progress in medical physics teaching and training. Since the BSc. program in biomedical physics started 17 years ago, there are now two MSc. programs, with the recent one having just started in 2020. Moreover, a residency program is expected to start very soon. All academic programs are accredited locally the AQACHEI and follow a curriculum in accordance with the IAEA guidelines. Students in these programs achieve almost all the competences in all areas specified by the IAEA recommendations. The facilities for cancer treatment have expanded as well to include five centers. These centers, along with other nuclear medicine and radiology facilities, provide medical physics students with the needed clinical training using the latest state of the art medical related technologies.

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