IMPACT OF 10 YEARS OF THE INERNATIONAL MASTER OF ADVANCED STUDIES IN MEDICAL PHYSICS

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Abstract— **The Master of advanced studies in medical physics (MMP) has been jointly organized by the International Centre for Theoretical Physics (ICTP) and the Trieste University since 2014, with support from IAEA. The MMP consists of one academic year followed by a year of supervised clinical training in hospitals. It aims to address the shortage of high-quality education and training for medical physicists in low- and middle-income countries (LMICs), equipping graduates with clinical skills and competencies to be applied in their home countries. The paper analyses the answers of 125 graduates, out of the 174 graduates up to the 2023, to a survey distributed in 2024 to evaluate the impact of the MMP on individual careers, clinical activities, and on the developed activities to contribute to the development of medical physics at national level.**

This paper analyses the responses of 124 graduates -out of a total of 174 graduates up to 2023 - to a survey distributed in October 2024. The aim is to evaluate the impact of the MMP on individual careers, clinical practice, and the graduates' contributions to the development of medical physics at the national level.

Keywords— **master after master, academic, clinical training, LMICs, survey.**

I. INTRODUCTION

The Master of Advanced Studies in Medical Physics (MMP) was jointly established in 2014 by the Abdus Salam International Centre for Theoretical Physics (ICTP) and the Trieste University with support of the IAEA. As an UNESCO and IAEA affiliated institution, the ICTP has been a driving force in advancing scientific expertise in the developing world for over 60 years. In line with this mission, the MMP programme aims to address the scientific demand for qualified and well-trained medical physicists in most of the low- and middle-income countries (LMICs). The programme requires important financial resources primarily provided by ICTP and IAEA, with additional contributions by TWAS (The World Academy of Science), KFAS (Kuwait Foundation for the Advancement of Sciences), and ACS (American Cancer Society).

The 2-year programme offers one academic year of theoretical classes followed by one year of supervised structured clinical training with the aim at addressing the scarcity of quality education and training of medical physicists in most LMICs [1]. An additional aim is to provide students with advanced academic knowledge and practical skills, to be brought back to their home countries and willing to train young medical physicists.

The academic education of the first year is covering the relevant specialties of medical physics, to prepare the student to enter, in the second year, in a formal clinical medical physics residency. The major outcome of the academic programme, based on IAEA recommendations [2], would be to provide students with a thorough grounding in the analytical methods and fundamental aspects of medical physics and instil an attitude of integrity, professionalism, critical-thinking and scientific rigor. Teaching is provided by academic staff, clinical medical physicists, radiation protection experts and health care professionals, like radiologists and radiation oncologist physicians.

This is followed by a full-time year of supervised clinical training in a medical physics department of a hospital in the programme's training network. The network for the clinical training comprises 26 Italian Medical physics department from university, oncology or general hospitals. The Resident practices mainly in a specific area of medical physics: diagnostic imaging or radiation oncology. The programme of activities developed and the assessment methodology of the acquired skills and competences are derived adapting the IAEA [3,4,5] and AFRA (African Regional Co-Operative Agreement for Research, Development and Training Related to Nuclear Science and Technology) [6] clinical training of medical physicist guidelines and are implemented in a resident's portfolio. At the end of the programme the resident has to defend a thesis on a research activity developed during the clinical training.

The programme was accredited by the International Organization for Medical Physics (IOMP) in 2016 and re-accredited in 2022**,** further enhancing the international recognition of the Trieste University degree**.** Additionally, graduates can pursue IMPCB (International Medical Physics Certification Board) certification exams at ICTP, thanks to the programme's collaboration with IMPCB since December 2018.

II. SURVEY RESULTS

Of the 174 graduates in the first 9 cycles of the programme 71% responded to the survey with the region and cycle distribution as reported in Table 2. On the financial support to the program: 76% and 16 % of graduates were sponsored respectively by IAEA and ICTP.

Table 2. Responses to the survey by the first 9 cycle graduates of the MMP programme (2014-2023).

Region	No. of graduates	No. of responders
Africa	85	56 (66%)
Asia	39	29 (74%)
Europe	12	10 (83%)
Latin America & Car	37	28 (76%)
Oceania	1	1 (100%)
Total	174	124 (71%)

With reference to the activity performed before joining the programme, 27% were studying, 57% working in medical physics on in related fields, 13% working in other fields, 2% were unemployed.

67% declared that present activity is what they wanted to do after the graduation and for 20% only partially. The MMP was significantly useful to achieve their aims for the 67% and only useful for the 30% of the graduates.

A. MMP graduate activities

The present occupation of the graduates is reported in Figure 1. 88% have a job, 5% are yet studying, usually in a PhD programme and 8% are not working. Typically, 45% resumed the position they had before joining the programme and 39% get a job in less than 1 year. The type of occupation is reported in Table 3.

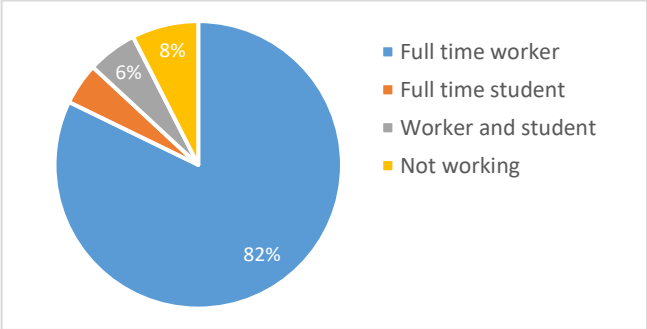

Fig. 1. Present occupation of the MMP graduates.

Independently from the present activity, Table 4 reports what they see themselves in the next 5 years, included the opportunity for a job abroad.

Table 3 Type of work reported by the of the 101 graduates having a job

Type of work	%
Clinical Medical Physics job	55
Clinical Medical Physics, Teaching, Research	26
Teacher and researcher in MP	3
Work not related to clinical medical physics	5

The last is an indication of the few positions of medical physics available in LMICs and the low salaries frequently associated to the non-recognised and not regulated profession. A few interesting comments reported: 'MMP has been a blessing in my professional life', 'All the individual and collective actions carried out to increase my salary and create the profession of medical physicists have failed … paradoxically my country is hiring expatriates to fill the shortage of medical physicists' or 'MMP gave me all the tools and knowledge to be able to face my profession abroad'.

B. Clinical medical physics activity

With reference to the clinical medical physics job, only 26 (40%) of the 66 working in radiotherapy are full time in this sub-specialty. Most of the MPs are sharing their time in different sub-specialties (RT, NM, DR and radiation protection) or as teachers and researchers, as reported in Figure 2.

This confirms the need to provide to our MMP students an education covering all areas of a medical physicist working in an hospital with a limited, sometime very limited, medical physics staff. In fact, 1% of the responders is reporting only 1 medical physicist in the hospital, 24% only 2 and 22% 2 or 3.

Table 4 Type of work foreseen in the next 5 years as reported by 122 graduates.

Type of work	Number (%)
In the home country:	
Clinical Medical Physicist	64 (53%0
Medical Physics lecturer/researcher	45 (37%)
Officer in the regulatory body	14 (12%)
In another country:	
Clinical Medical Physicist	39 (32%)
Medical Physics lecturer/researcher	33 (27%)
Officer in the regulatory body	32 (27)

On the radiation oncology practice, some questions are providing regional information on the type of pathologies treated, treatment technologies and techniques used. Figure 3 shows the large percentage of palliative treatment performed in the MMP centres, in particular in Africa, Asia and LA and Caribbean regions. This large number of palliative treatments justifies the simple 2D/3D radiotherapy technique used in more of the 40% of the cases in the same regions. Table 4 reports the average number and type of therapy machine installed per centre in the different regions, showing the large number of cobalt machine still used in African countries.

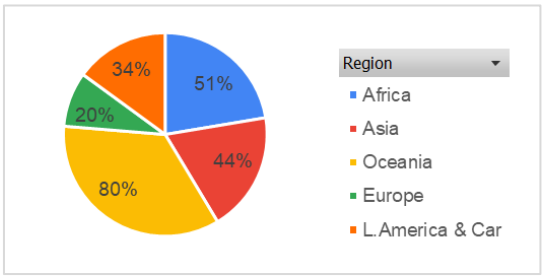

Fig. 3. Radiotherapy practice. Percentage of average palliative treatments on the total number of treatments per geographical region in the MMP graduates centres.

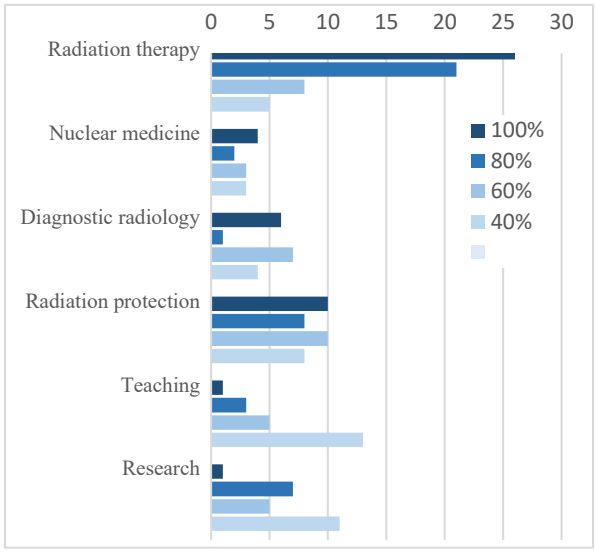

Fig. 2. Percentage time spent in the different medical physics sub-specialties, radiation protection or as teacher and researchers.

At the same time, a quite large percentage of the treatments are performed with modulated techniques, to demonstrate that availability of at-the-state-of-the-art technologies and that staff is trained to introduce advanced therapy techniques in all the regions (Figure 4).

Table 4 Average number of therapy machine per centre and per region.

Region	No. ^{60}Co	No. of linacs	No. brachy
Africa	1.8	1.6	1.2
Asia	1.0	2.5	1.1
Oceania	1.0	2.0	1.2
Europe	1.0	3.2	
LA and Caribbean	1.5	2.1	1.1

On diagnostic radiology and nuclear medicine practice, no one of the MMP graduates is full time working in these sub-fields and, in general, very few MMP graduates are involved (Figure 2). But, those involved are performing a large number of tasks demonstrating good competences (Figure 5).

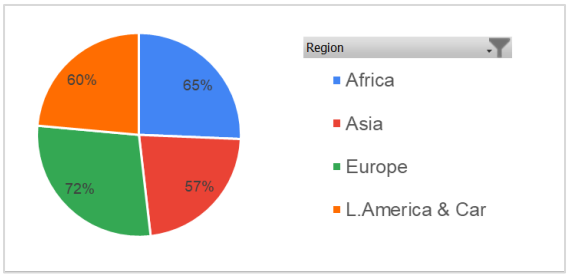

Fig. 4. Average fraction of IMRT/VMAT therapies on the total number of treatments in the centres of the MMP graduates per region.

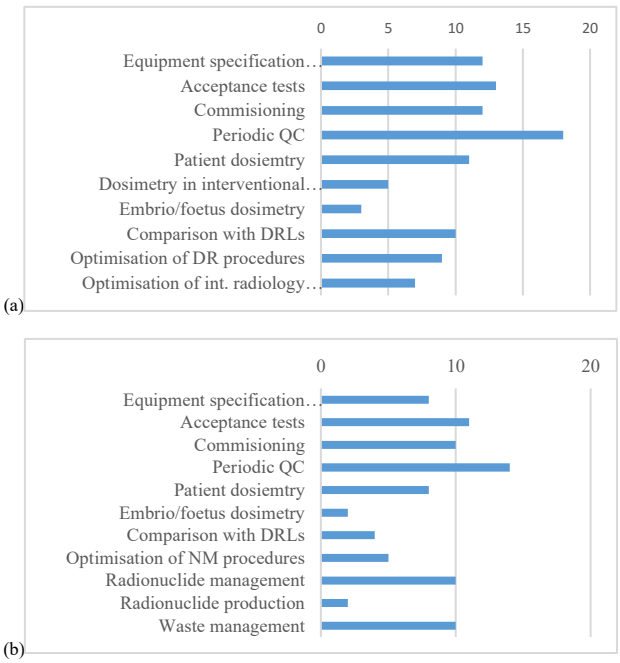

Fig. 5. Type and frequency of diagnostic radiology (a) and nuclear medicine (b) tasks performed by the MMP graduates.

Almost 50% of the graduates are reporting part-time involvement in radiation safety, acting as RPE or RPO. 43% of them are the only experts in the hospital and covering all regulation requirements (Figure 6).

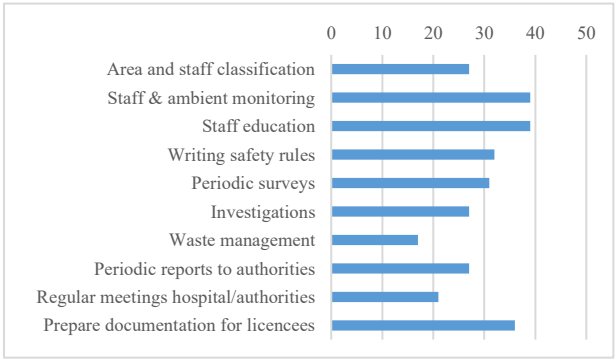

Fig. 6. Type and frequency of radiation safety tasks performed by the MMP graduates.

C. *MMP graduates for the development of medical physics in the country*

In order to understand how the MMP graduates are contributing to the grow of the medical physics in the country, a number of questions identified the activities performed in parallel to the clinical work. 73 (58%) were declaring to teach or train medical physicists, to participate to IAEA national or regional projects, to represent the ministry of health or other national institutes abroad, to act as expert in national institution or to act, 7 of them, as expert in IAEA missions (Figure 7).

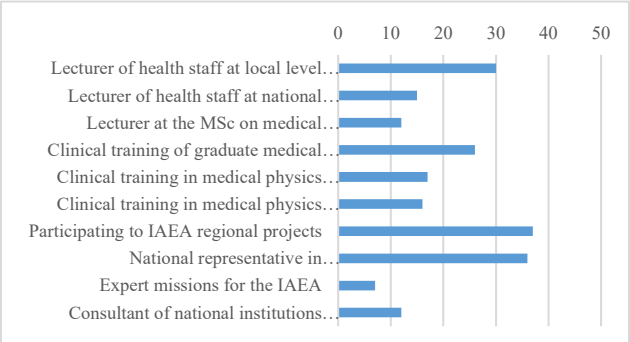

Fig. 7. Activities outside the hospital to understand the impact of the MMP graduates on the development of medical physics in the country.

D. MMP programme evaluation, profession recognition and medical physics association

On the evaluation of the MMP programme, 89% of the responders consider it 'Relevant for the current career' and 10% 'Partially relevant'. 50% are using the educational material for their teaching, 42% distribute to colleagues, 23% uses in national courses/workshops. On the clinical training, 72% are reporting that almost all the staff of the medical physics department in the hospital was involved in the supervision, 72% had regular meeting with the supervisor and 67% declare the training was covering all modules of the proposed portfolio. Finally, 71% report they reached competences able to directly perform the different task. After the, programme, 70% have continuous or occasional contacts with their supervisors for advices. Most graduates consider the year clinical training too short and not sufficient to acquire sufficient skills and competences.

The formal recognition of the profession of clinical medical physicist is a challenge internationally. 86% of the graduates declare that the profession is not recognised in the home country. On the MMP degree recognition, for 58% of them the country officially recognised the MMP degree without difficulties. And, 53% of them has been recognised as clinical medical physicists, while for 11% it was requested to an additional period of clinical training. For 31% the degree was recognised as master of science degree.

On the interest to get an international certification, 8 graduates have completed the IMBCB certification and other 15 have passed some exams; 6 got another certification.

Medical physics association is not present in the country for the 46% of the graduates. When the association exists, 44% participate to the activities and 22% frequently contribute to them.

III. CONCLUSIONS

The Master of Advanced Studies in Medical Physics offers participants a highly regarded academic programme, complemented by a structured one-year clinical training, facilitated through a comprehensive hospital network. The programme is designed to provide academic education and practical training, aligning with international recommendations to ensure standardised competency development.

The MMP has demonstrated its effectiveness in equipping participants with the necessary expertise, with 73% of surveyed graduates returning to their home countries to apply their acquired skills.

The programme received international accreditation from the International Organization for Medical Physics (IOMP) in 2016 and was re-accredited in 2022. Since 2018, in collaboration with the International Medical Physics Certification Board (IMPCB), graduates who meet the required criteria have the opportunity to undertake examinations leading to international certification.

Since the 2015–16 cycle, the programme has benefited from IAEA support, both in candidate selection and through financial aid, awarding the highest number of fellowships to date.

A survey conducted among 174 graduates from the first nine cycles of the programme received 124 responses, offering valuable insights into career trajectories, clinical activities, and initiatives contributing to the advancement of medical physics at the national level.

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