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Current Status of Medical Physics Education and Workforce in AFOMP Region

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ABSTRACT

Introduction: Medical physicists [MP] employed in radiation medicine are health professionals [1, 2] and are responsible for the radiation protection of the patient, staff, and the public. IAEA has prescribed minimum educational and training requirements for being clinically qualified medical physicists [CQMP], [3]. As the application of ionizing radiation is increasing in the diagnosis of various ailments and treatment mostly in radiation oncology, radiology & interventional radiology, and nuclear medicine across the globe, more and more MPs are required to take care of rising demand [4]. In the Asia Oceania region, the rapidly growing health care system requires an increasing number of MPs and many countries in this region have started masters in medical physics [MMP] program. The quality of the MMP program and the competency of MPs produced by the institutes/universities imparting the education and training needs to be of the required standard and requirement. The aim of present study was to access the current status of medical physics education and workforce in the Asia Oceania Federation of Organisations for Medical Physics [AFOMP] region.

Material and Methods: To access the status of medical physics education in the AFOMP region data is collected from 21 countries and national medical physics organizations [NMO] of Asia Oceania region regarding the MMP education program, intake capacity, and certification, registration.

Results: It is observed that 105 institutes in the AFOMP region are conducting the MMP program with a total annual capacity of about 800 students. Further, we observed that in 9 countries the MMP programs are accredited, and 11 countries have MP certification boards. From the present analysis, it was observed that the number of medical physicist in AFOMP NMO varies from 0.56 to 20.0 MP per million population.

Conclusion: To meet increasing needs of P, more MPE programs recommended.

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Introduction

Medical physics is one of the challenging and rewarding applications of physics to medicine. The discovery of X – rays and radioactivity and its increasing application in healthcare for diagnosis and treatment has stimulated the demand and growth of medical physics in radiation medicine. As per the UNSCEAR 2008 [5] report, over 3.6 billion diagnostic radiological procedures, 5.1 million radiotherapy treatments and 33.5 million nuclear medicine procedures are performed every year. Further the report shows that over 90 % contribution of ionizing radiation dose to humans due to manmade radiation is because of medical application of radiation. Due to the increasing use of ionizing radiation in healthcare and associated radiation risk, it is mandatory to employ the services of radiation professionals including CQMP and or radiation safety experts depending upon the modality of radiation application [2]. As the CQMP are health professionals [1, 2] and deal with the wellbeing of the humans ensuring safe application of radiation for diagnosis and treatment needs professional competency. The IAEA Basic Safety Standards [2] have defined the Medical Physicist as "a health professional, with special education and training in the concepts and techniques of applying physics in medicine, and competent to practice independently in one or more of the subfields (specialties) of medical physics". To become a competent CQMP professional, IAEA [3] has prescribed the educational requirement such as

- A degree in physics, engineering, or equivalent physical sciences from university
- Postgraduate academic qualification in medical physics
- Minimum of 2 years full time equivalent structured clinical in-service training in hospital

International Organisation of Medical Physics [IOMP] and the American Association of Physicists in Medicine [AAPM] have endorsed the IAEA Human Health Series no. 25 [3] document. Further IAEA has given clinical training requirements for Radiation Oncology Medical physicists- ROMP [6], Radiology Imaging Medical Physicist – RIMP [7] and Nuclear Medicine Medical Physicists –NMMP [8]. Further

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IOMP statement 2 prescribes the minimum syllabus for the MMP [9] to facilitate the member states to implement the MMP program.

In all parts of the world, the demand for CQMP has increased due to the increasing application of radiation in healthcare especially in radiation oncology, interventional radiology and nuclear medicine procedure, high tech procedures, complexity of the radiological procedure and associated stringent quality assurance requirement and the regulations for implementing radiological safety. There is shortage of CQMP which is compromising the quality and growth of radiation application in healthcare [10]. To cope with the growing demand for CQMP, many countries have started MMP programs and existing programs have increased the student intake capacity. However, the quality education and more so of CQMP by virtue of health professions responsible for the health of mankind, is of paramount importance. To access the quality of education of the MMP program in terms of adequate qualified teachers, adequate equipment/labs for carrying out practicals, the examination and assessment system and the infrastructure, accreditation of the MMP program is essential. Further to access the individual professional competency of the MP, certification of MP by certification board appointed/approved/recognized by ministry of health/education or regulatory authority of the country is needed. The accreditation and certification boards can be international, regional, or country-specific.

Materials and Methods

AFOMP founded in 2000 as professional organization and is one of the largest regional organizations [RO] of IOMP. The main aims and objectives of AFOMP are to promote the cooperation and communication between medical physics organizations in the region, to promote activities related to medical physics and to promote the advancement in status and standards of practice of the medical physics profession. As per the bylaws and regulations of IOMP, the IOMP national medical physics organization [NMO] can become member of RO in that region with some exceptions. AFOMP has at present 19 NMOs as full members and 2 NMOs are affiliate members (all are IOMP NMO] which covers Asia-Oceania region where over 4.5 billion people live. The NMOs of the South East Asia Federation of Organizations for Medical Physics [SEAFOMP] are also member of AFOMP. The middle east countries are also part of Asia and therefore the NMOs of Middle East Federation of Organizations of Medical Physics [MEFOMP] also can become members of AFOMP for better functioning and cooperation. This region has over 50 countries however many countries have not a single medical physicist or the number of medical physicists is exceedingly small to form a medical physics organization. This region is remarkably diverse socioeconomically, culturally and the per capita GDP varies from about US$ 700 to US$ 70000. Some countries in this region are growing economically very rapidly so also fast growth of healthcare facilities. Further the population is aging requiring increasing healthcare facilities. This has led to an increase in demand for CQMP and therefore many countries have started MMP programs. To access the availability and requirement of CQMP in this region and to access the growth of MMP program, a questionnaire was sent to AFOMP NMOs. The questionnaire contained 20 questions to get details about the MMP program, accreditation, and certification of the MMP program and the number of MP's [annexure1]. We have received exceptionally good response and 21 countries /NMOs have provided the detailed information until December 2020 is included in the study. The data received is verified from the NMOs however there can be slight variation in the responses due to dynamic situations taking place. The data is analyzed and tabulated.

Results

The number of medical physicists in each country of the AFOMP region is given in table 1. It is observed that the number of medical physicists per million population varies from 0.56 MP/million to 20.0 MP/million with average of 2.67 MP/million. For many countries in AFOMP the number of MP/million population is far below the number of 18 MP/million recommended by European Federation of Organisation for Medical Physics-EFOMP [11]. Further we made the comparison of number of MP/million population for all the RO of IOMP and found that the number of MP/million in AFOMP region is far below the number of MP/million in comparison with USA & Canada and EFOMP region and is tabulated in table -2. Further we analyzed the additional MP's required to take care of cancer patients requiring radiation therapy treatment assuming that 60 % of cancer patients require treatment by radiation therapy and for every 400 new cancer patients of radiotherapy treatments needs at least one medical physicist and is tabulated in table -3. The incidence of cancer patients for each AFOMP country is taken from the GOBOCON2018 [12].

Table 1. Number of medical physicists and population in AFOMP countries

Country/NMO	Number of Medical Physicists (Approx)	Physicists in radiotherapy Number	%	Physicists in Radiology Number	%	Population million	Medical Physicists/ million population
Australia	500	300	60.00	143	28.60	25	20.00
Bangladesh	200	70	35.00	00	0.00	170	1.18
Peoples Rep. of China	4000	3500	87.50	50	1.25	1400	2.86
Hong Kong	120	85	70.83	32	26.67	7	17.14
India	1600	1500	93.75	15	0.94	1380	1.16
Indonesia	438	114	26.03	306	69.87	273	1.60
Iran	310	250	80.65	45	14.52	83	3.74
Japan	2000	850	42.50	50	2.50	126	15.87
S. Korea	360	209	58.06	10	2.78	51	7.06
Malaysia	275	126	45.82	53	19.27	32	8.59
Mongolia	10	10	100.00	00	0.00	3	3.33
Myanmar	30	30	100.00	00	0.00	54	0.56
Nepal	18	17	94.44	00	0.00	29	0.62
New Zealand	90	70	77.78	10	11.11	4.8	18.75
Philippines	130	70	53.85	24	18.46	109	1.19
Singapore	65	39	60.00	09	13.85	5.8	11.21
Republic of China, Taiwan	350	200	57.14	10	2.86	23	15.22
Thailand	200	137	68.50	23	11.50	69	2.90
Vietnam	155	115	74.19	00	0.00	97	1.59
Pakistan	150	120	80.00	15	10.00	220	0.68
Sri Lanka	50	40	80.00	05	10.00	22	2.27
	11051	7852	71.05	800	7.24	~ 4132	2.67

Table 2. Number of medical physicists [MP], population and number of MP/million population for 7 regions organization of IOMP

Sr. No.	Region/Country	Number of Medical Physicists	Population	MP/ million population
01	North America [USA & Canada]	9000	338+38=368	24.46
02	EFOMP	9000	750	12.00
03	FAMPO	800	1300	0.62
04	ALFIN	1400	700	2.00
05	MEFOMP	600	400	1.50
06	AFOMP	11051	4132	2.67

EFOMP- European Federation of Organizations for Medical Physics
FAMPO- Federation of African Medical Physics Organization
ALFIN- Latin American Medical Physics Association
MEFOMP- Middle East Federation of Organization for Medical Physics
AFOMP – Asia Oceania Federation of Organization for Medical Physics

Table 3. Requirement of additional medical physicists to treat the cancer patients by radiotherapy.

Country/NMO	Medical Physicists In Radiotherapy	New Cancer patients X 10^3 **A**	Patients requiring Radiotherapy. 0.6 **A** x 10^3	Number of Medical Physicists required for RT	Short fall of Medical physicist for RT Number	%
Australia	300	150	90	225	Nil	0.0
Bangladesh	70	170	102	255	185	264
Peoples Rep. of China	3500	4300	2580	6450	2950	84
Hong Kong	85	35	21	53	Nil	0.0
India	1500	1400	840	2100	600	40
Indonesia	114	350	210	525	411	360
Iran	250	110	66	165	Nil	0.0
Japan	850	1100	660	1650	800	94
S. Korea	209	240	144	360	151	72
Malaysia	126	44	26.4	66	Nil	0.0
Mongolia	10	5.6	3.36	08	Nil	0.0l
Myanmar	30	70	42	105	75	25
Nepal	17	26.2	15.7	39	22	129
New Zealand	75	36	21.6	54	Nil	0.0
Philippines	70	140	84	210	140	200
Singapore	39	30	18	45	06	15
Republic of China, Taiwan	200	120	72	180	Nil	0.0
Thailand	137	170	102	255	88	64
Vietnam	115	160	96	240	125	109
Pakistan	120	170	102	255	135	113
Sri Lanka	40	24	14.4	36	Nil	0.0
	7852	8831200	5298720	13276	5424	69

Discussion

Out of 21 countries/NMO's surveyed from AFOMP region, China, and India accounts for 2780 million population and are 67.3 % of the population of the region [4132 million] and has 5.7 million cancer patients 64.6 % of cancer patients of AFOMP region [8.83 million]. Goss PE et al [13] have studied the cancer incidence in China, India and Russia and reported that China, India and Russia all together account for approximately 40% of the global population. These countries have in common large geographics and fast-growing economies. The leading contributing factors to the rise in cancer incidence are the increasing number of old age people, changing lifestyles and deprived socio-economic conditions with inadequate healthcare services, severe contamination of atmosphere, and growing occurrence of oncogenic communicable diseases.

In the present study it is observed that out of over 8.83 million cancer patients in AFOMP region, 5.3 million cancer patient needs treatment by radiotherapy and 13276 radiotherapy MP's. However presently only about 7852 MP's are working in radiotherapy, there is a shortfall of 5424 MP's [69 %] for radiotherapy. Bangladesh has a 2.7-fold shortfall of CQMPs, the highest in the AFOMP region. Medical physicists are also needed in radiology including interventional radiology and nuclear medicine [2, 14]. The analysis of data collected revealed that the maximum number of medical physicists 71.05 % are recruited in Radiation Oncology [RO] and only 7.24 % are in radiology exclusively. As per the EC directives [15], every member country of the EU needs to ensure services of CQMP or Radiation Protection Expert [RPE] and over 25 % of MP's are recruited in radiology [Personnel communication- EFOMP]. However, in the AFOMP region no such kind of union of council exists like the EU and therefore every country has its own way to enact the laws/provisions for implementing radiological safely. Further as per the membership data records of AAPM members, 44 % of medical physicists are in radiation oncology and 11 % in radiology. Further in our study it was observed that in 4 countries, 100 % MPs are recruited in RO and no MP is recruited exclusively in radiology. In Indonesia over 69.9 % of MP's are recruited in radiology, the highest in the AFOMP region, this is due to the act/regulation mandating services of MP in radiology in Indonesia [16, 17]. If we consider the total requirement of CQMP in RO, IR, and NM then at least three-fold increments in MP are required. The Call for Action adopted at the Bonn Conference on Radiation Protection in Medicine, organized by the IAEA in collaboration with World Health Organization (WHO) concluded that recognition of medical physics as an independent health profession with specific radiation protection responsibilities is a key step to strengthen radiation safety culture in health care. Further WHO promotes the role of the medical physicist in ensuring radiation safety and quality in medical exposures and supporting the implementation of the Basic Safety Standards (BSS) by stressing the increase in the role of medical physicists in diagnostic radiology, radiation therapy and nuclear medicine services [18]. Pawiro et al [19] have studied the status of medical physics recognition in SEAFOMP, 9 countries participated in the study, and reported that out of 1027 members, 725 are working as clinical MP and only 88 CQMP (8.5%) are certified in 7 countries. Further they reported that in only 4 countries [44.4 %] out of 9 have MMP and 6 (66.7 %), 4 (44.4%) and 2 (22.2%) countries the CQMP is recognized as health professional, certified, and registered respectively, a long way to go. All these 9 countries of SEAFOMP are part of AFOMP.

The data of MMP programs and the yearly student intake capacity of the present study are tabulated in table – 4. It is observed that 105 institutes/universities are imparting MMP with total yearly student intake capacity of over 800 and three institutes/universities in Vietnam with student capacity of 60 are offering bachelor in medical physics.

Table 4. Number of institutes/Universities offering master Medical physics program and number of students every year in AFOMP region.

Country/NMO	Number of Institutes/ Universities offering MMP	Number of students per year	MMP offered in specialty	Accreditation of MMP programs	Certification Boards For certifying CQMP	Registration of CQMP as Health professional by Govt or another agency
Australia	06	30	Medical Physics	Yes, ACPSEM	Yes, ACPSEM	Yes
Bangladesh	03	15	Medical physics, Physics	No	No [Certified by IMPCB]	No
Peoples Rep. of China	07	60	Medical Physics & Engineering	No	Yes, CMA	No
Hong Kong	01	15	Medical Physics	Yes, HKAMP, HKIPM	Yes, HKAMP, HKIPM	Yes
India	22	250	Medical Physics, Radiological Physics, Physics	No	Yes, CMPI	No
Indonesia	06	30	Medical Physics	Yes, Govt.		Yes
Iran	14	100	Medical Physics	Yes, Ministry of Health	Yes, IAMP.	Yes, AEO, IRAN .
Japan	24	100	Health Sciences Medical Sciences	Yes, JBMP	Yes, JBMP	Yes
S. Korea	05	20	Medical Physics & Engineering, Physics	Yes, KMPCB	Yes, KMPCB	Yes
Malaysia	02	40	Medical Physics	No	No	Yes
Mongolia	00	00	NA	No	No	No
Myanmar	00	00	NA	No	No	No
Nepal	00	00	NA	No	No	No
New Zealand	01	10	Medical Physics	Yes, ACPSEM	Yes, ACPSEM	Yes
Philippines	01	10	Medical Physics	No	Yes	No
Singapore	00	00	NA	No	No	No
Republic of China, Taiwan	03	35	Medical Physics	Yes	Yes	No
Thailand	08	30	Medical Physics	Yes	Yes	Yes
Vietnam	03 [bachelor]	60 [BSc]	Medical Physics	No	No	No
Pakistan	02	20	Physics	No	No	No
Sri Lanka	02	15	Physics	No	No	No
Total	105	800		Yes- 09 No- 12	Yes- 11 No- 10	Yes- 9 No-13

HKAMP- Hong Kong Association of medical physics, HKIPM- Hong Kong Institute of Physics in Medicine
CMA- Chinese Medical Association, CMPI- College of Medical physicists of India
IAMP- Iran Association of medical physics
AEO- Atomic Energy Organization

It was observed that out of 21 countries/NMOs 16 counties/NMOs have MMP program, one country has only bachelors MP program and 4 countries do not have any MP education program. As we need competent CQMP as health professionals and therefore the standard of education program and individual professional competency needs to be accessed and maintained by way of accrediting MMP program and certification of individual MP. Accreditation is a process by which the quality of education on various parameters is accessed and evaluated.

For accreditation of MMP there are few accreditation bodies/boards at the national and international level, some of them are the Commission on Accreditation of Medical Physics Educational Programs -CAMPEM [20] for North America, Australian College of Physical Scientists and Engineers in Medicine- ACPSEM[21] provides a Training, Education and Assessment Program (TEAP) in three disciplines of medical physics by way accrediting university courses that provide education in Medical Physics and clinical departments that provide training in Medical Physics, Japanese Board for Medical Physicist Qualification –JBMP [22] is certifying Medical Physicist in Japan, Korean Medical Physics Certification Board – KMPCB [23] has undertaken the job of certification of medical physicist in S. Korea and IOMP [24] has started its accreditation program by establishing IOMP accreditation Board in 2016 to facilitate accreditation of MMP program, residency program and CPD program in IOMP NMO's. There are many advantages of IOMP accreditation of the medical physics education and training programs. Hayashi N et al [25] have reported a study on medical physics status in Japan for the future. They observed the phenomenal growth of medical physics and educational activities in Japan in last 10 years. Though the certification of medical physicists in Japan started as early as 1987 it took a boost when the JBMP certification was established in 2009. Another study by Mahdavi S R et al [26] has discussed the historical background of medical physics in Iran and starting of first master's program in Medical Physics in 1976 at Ahvaz Jundishapur University with the start of MMP education and subsequent growth. They have discussed the quality of medical physics education and the need for improvement to cope with challenging requirements. They have also recommended improvement in curriculum including long-term clinical courses in four major subspecialities of radiotherapy, medical imaging, nuclear medicine, and radiation protection.

Maclean et al [27] under an IAEA/RCA regional project have developed recommendations on accreditation and certification for the East Asia and Pacific region. To overcome shortage of CQMP and accreditation of MMP, certification of CQMP and registration of CQMP as health professional, they have proposed a three-layered approach with a multi-disciplinary national body responsible for the accreditation of MMP, certification and national registration of CQMP. They emphasized that only after proper assessment of minimum educational standards of the MMP program, the accreditation should be awarded to institutions which are imparting the education and training. They further recommended that after examining the competency, through written, oral, and practical examination of the candidate which is needed to discharge the duties as CQMP only be certified. They have cautioned that accreditation and certification processes be carefully designed nationally and regionally so as not to obstruct expansion in the profession which is much needed. These guidelines are especially useful for AFOMP to ramp up the MMP program capacity to produce more certified CQMP and they are not only recognized but also registered as health professionals. Kron T et al [28] have reported the third survey carried out in 2014, earlier were 2008 and 2012, and reported that radiation oncology medical physics practice has not changed significantly over the last six years [2008-14] in the Asia Pacific Region. They observed that though the number of MPs has doubled in the period, however at the same time the rise in the number of cancer patients and the complexity of treatment techniques and technologies have increased dramatically, jeopardizing the increase in MPs.

In the present study we have observed that out of 105 education programs from 16 countries, only 9 countries the MMP programs are accredited and only 10 countries have registered them as health/allied health professionals. Further the postgraduate degree offered is in the specialty of medical physics (13 Countries), Radiological physics (1 country), Physics (5 Countries), Medical Physics and Engineering (2 Countries), Health Sciences/Medical Sciences (1 Country), Recently IOMP has accredited three MMP programs in S Korea and many more institutions are coming forward to get the MMP accredited by IOMP. Further for wider acceptance and credibility of the national medical physics certification boards [NMPCB] of the country, International Medical Physics Certification Board [IMPCB] has started accreditation of the NMPCB and has accredited three NMPCB in the AFOMP region [29, 30]. To facilitate the certification of individual MP from a country where no NMPCB exists, IMPCB has certified 37 MPs after written, oral and practical examinations. IOMP accreditation of the medical physics education program and IMPCB accreditation of NMPCB are becoming useful and popular for accreditation of MMP and certification of CQMP; AFOMP counties have taken advantage of this. To help member countries IAEA has brought out the guidelines for the certification of clinically qualified medical physicists which is endorsed by IMPCB and IOMP [31]. The guidelines and framework support the establishment of certification body in every member state of the IAEA.

Conclusion

The overall situation of medical physics education & training, accreditation, certification, and registration in AFOMP region has increased in the last 20 years, however, the rising population, increasing number of patients needing radiological services and the complexity of advanced techniques, we need a greater number of certified CQMP for providing effective and efficient services. To bridge the huge gap between supply and requirement, a lot needs to be done for the availability of sufficient number of certified CQMP in the AFOMP region.

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