Review Article

Professional Master of Pharmacy Education in China

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ABSTRACT

Background: The Professional Master of Pharmacy (M. Pharm.) education program in China has undergone 10 years of development and has rapidly achieved great progress. The aim of this study was to summarize and introduce the development of M. Pharm. education in China. **Materials and Methods:** The data related to M. Pharm. education in China was obtained from literature retrieval, the Ministry of Education of the People's Republic of China (MOE), and related university websites. Some data was obtained from the Chinese National Steering Committee for the Professional Degree of Pharmacy Graduate Education (NSCPDP). The NSCPDP data was a result of questionnaires sent to 113 training institutions in 2021 and from a survey of recent graduates of China Pharmaceutical University (CPU) in 2019. **Results:** The main findings are that the training goals, degree education, qualifications and admission standards of institutions, training fields, curriculum setting, teaching methods, professional practice, faculty teams, quality assurances and evaluations, degree awarding and employment direction in the M. Pharm. education system are relatively well developed, and that M. Pharm. education has become an important part of pharmacy education in China. **Conclusion:** M. Pharm. education in China not only draws lessons from foreign advanced experience in the administration of schools and universities, but also has formed its own Chinese characteristics and emphasis. M. Pharm. education in China has a bright future through a program of continuous quality improvement.

Keywords: Professional master of Pharmacy, Education Program,Cultivation Model, Present and Future, China.

INTRODUCTION

The professional degree, as opposed to the strictly academic degree, focuses on professional, practical, and academic education. In addition, it is career-oriented and is characterized by the development of practical ability (practical application of knowledge).

The goals of professional degree education for graduate students include meeting the needs of society for specialized expertise in specific fields and the development of high-level, application-oriented expertise with strong practice ability and professional ethics in order to engage in creative practical work.[1] The United States is the birthplace of professional degree education and is also the country with the highest level of development in professional degree education. Through more than a hundred years of development, the United States has formed a well-structured and diversified professional degree education system that is the largest in the world, and it is imitated by many other countries. Professional degrees in the United States are divided into professional master's degree, professional doctoral degree, and professional first degree, which are mainly found in programs of medicine, pharmacy, law, education, business administration, engineering, and agriculture.[2] In addition, professional degree education for graduate students has developed greatly in the United Kingdom, Japan and other developed countries,[3-5] and has become a major graduate degree education program in the disciplines including Business Administration, Accounting, Public Policy, Education, Public Health, Information Technology, Atomic Energy, Pharmacy and etc.

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Master of Business Administration (MBA), the first professional degree in China, was first established in 1990 and was the prelude to professional graduate degree education development in China.[6] By 2021, China had established 47 professional master's degree programs and 13 professional doctoral degree programs in the main fields of China's national economic and social development.[7] Before 2010 however, pharmacy graduate education programs were only academic degrees and the graduates were mainly engaged in a basic research study such as teaching and scientific research. In 2010, after deliberation at the 27th meeting of the Academic Degrees Committee of the State Council of China, it was decided to establish a professional master of pharmacy (M. Pharm.) degree to meet the increasing social needs for applied pharmaceutical expertise. In 2011, 38 universities were authorized to admit 640 graduate students to the professional M. Pharm. Programs.[8] However, compared with the recruitment for the academic master's degree, this proportion was considered very small. In 2014, 610 graduate students were the first group to be awarded the M. Pharm. degrees in China. In the past five years, by intensifying efforts to adjust and optimize the structure of graduate education, the enrollment of M. Pharm. students has been skyrocketing in China. Compared to 2011, student enrollment increased by 970% in 2020 and the cumulative number of admissions was 20,240. In 2020, 2070 graduate students were awarded the M. Pharm. degree, an increase of 158% compared to 2015 (Figure 1). By the end of 2020, the total number of M. Pharm. degrees awarded was 9081. Through ten years of development through 2021, 113universities in China were accredited to recruit graduate students for the M. Pharm. program with Chinese characteristics. These programs will develop many high-level experts for the pharmaceutical field.

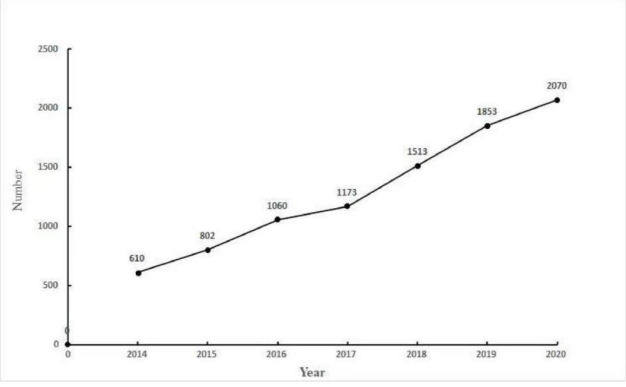

Figure 1: Number of M. Pharm. degrees awarded in the recent seven years in China.

In this paper, we summarize and introduce the development of M. Pharm. education in China since its inception in 2010. The emphasis is on the training goals of M. Pharm. degree education, qualifications and admission standards of institutions, training fields, curriculum setting, teaching methods, professional practices, faculty teams, quality assurances and evaluations, degree awarding, and employment direction. We also compare and contrast the differences of M. Pharm. education between China and other developed countries, expound the challenges and opportunities faced by M. Pharm. education in China, and predict the future development and reform direction to professional graduate degree pharmacy education in China.

MATERIALS AND METHODS

The data related to M. Pharm. education in China was mainly obtained from literature retrieval, the Ministry of Education of the People's Republic of China (MOE), and related university websites. Some data was obtained from the Chinese National Steering Committee for the Professional Degree of Pharmacy Graduate Education (NSCPDP). The NSCPDP data are the results from a questionnaire survey of 113 training institutions in 2021 and graduates of China Pharmaceutical University (CPU) in 2019.

RESULTS

The goal of M. Pharm. education

According to "the Program Settings of M. Pharm. Degree" from the Academic Degrees Committee of the State Council of China,[9] the goal of M. Pharm. education is to train high-level application-oriented experts with good political, ideological qualities and professional ethics, and with distinguished abilities to innovate and solve practical problems in the professional pharmacy fields such as manufacturing, production, distribution, and supervision of pharmacy technology.

Qualifications and admission criteria for the M. Pharm. degree

Since 2010, the development of professional master's degree education has been rapidly advancing in China. The Academic Degrees Committee of the States Council approved 28 and 34 new graduate training institutions of pharmacy in 2014 and 2017, respectively, which has greatly increased the number of M. Pharm. graduates. In the future, the structure of M. Pharm. education will be further optimized and the instructional scale of professional degree education will be further expanded. By 2020, 113 public training institutions were qualified to

recruit M. Pharm. students, including 58 comprehensive universities and 55 medical schools.[10]

The Academic Degrees Committee of the State Council entrusts the NSCPDP to establish the standards. First, the colleges or universities submit for approval the corresponding required accreditation materials. Then, after the submission evaluated by the panel of experts, the Academic Degrees Committee of the State Council examines and approves the enrollment qualification of M. Pharm. program. This model not only has the characteristics of government supervision, authority, and wisdom, but also means that once approval is made it becomes an administrative order and universities must execute it. At present the master's degree pharmacy education including M. Pharm. program in China is all undertaken by public institutions.

The admission candidates for the M. Pharm. program are primarily recent undergraduates. A few junior college graduates are also eligible to take the entrance examination if they also meet the requirements of English, years of employment, and required subjects. Most M. Pharm. programs have full-time students while 27 universities also accept part-time students. The basic length of study is 3 years, but some colleges or universities approve flexible lengths which can be 2-4 years. A cross-major application is allowed in China for graduate pharmacy applicants. Undergraduate students with non-pharmacy majors are only required to take the preliminary national post-graduate entrance examination and a second examination organized by the admitting colleges or universities. Admission to the program requires successful passing of the entrance exams. In terms of Chinese government enrollment policy, the state established a unified standard that outlines the required educational background and working years of the applicants and accepts successful admission scores as the admission criteria. The "state unified standard" is the fundamental principle for the admission of M. Pharm. students.

Training programs of M. Pharm. education

At the beginning of establishing M. Pharm. education in China, there were no unified training programs at the national level and a wide variety of programs were experimented. The aim was to help each school or university set up its own training program in accordance with the characteristics and advantages of each school or university. At present, Chinese M. Pharm. education covers three areas of training: clinical pharmacy, industrial pharmacy, and management pharmacy (Table 1). Apart from this, colleges or universities may add other areas of training according to their interests and expertise. For example, programs of drug quality and process control at CPU, polypeptide self-assembly and biomimetic therapy at Peking University, and natural medicine chemistry research at Shenyang Pharmaceutical University have been established. Unlike the Pharm. D. program in the United States, whose goal is to train clinical pharmacists, the goal of M. Pharm. education in China is to train service-oriented experts in various pharmaceutical specialty areas. Therefore, the M. Pharm. training programs cover the whole pharmaceutical industry chain.

The Curriculum of M. Pharm. education

The M. Pharm. education implements a credit system, and the theoretical courses can be completed in half a year to a year. The curriculum is based on "the Training Program Guide for M. Pharm. education" formulated by the NSCPDP in 2010, the "Guide to Core Courses for M. Pharm. Students" established in 2019, and also according to each school's or university's area of interest and expertise. The M. Pharm. curriculum is mainly composed of five modules: public courses, general theory courses, professional field courses, theory of practical training courses, and professional knowledge courses. According to the regulations of the NSCPDP, graduate students in the M. Pharm. Degree program should complete no less than 20 credit hr of theoretical courses and no less than 4 credit hr of practical courses (minimal practicum time of one year). On this basis, CPU has set courses and credits by itself, and the total credit requirement is 28 credits, which is higher than the basic requirements of the NSCPDP (Table 1).

From the curriculum content in each training program, the public courses are mainly compulsory courses stipulated by the MOE. The general theory course mainly teaches the core theories and technical methods of the pharmacy field. Professional field courses are elective courses designed to deepen professional knowledge and broaden knowledge structure. The latter present the characteristics of an interdisciplinary and diversified education and encourage students to choose courses that cross professional fields to expand their scope of knowledge. As a bridge course between theoretical knowledge and practice, the practical courses mainly integrate knowledge, contents, and preliminary practice skills. A professional knowledge development course is a new online course module offered by CPU during the COVID-19 period. The module mainly focuses on the new progress and new situation in the current professional field. The M. Pharm. curriculum is manifested in the form of disciplinary structure, taking a knowledge structure based on the knowledge system of

Table 1: The program, training direction, and theoretical curriculum of M. Pharm. education at CPU.

Program	Training Direction (or type)	Public Courses (6 credits)	General Theory Courses (4 credits)	Professional Field Courses (10credits)	Theory of practical training courses (2 credits)	Professional Knowledge Courses (2credits)
Clinical Pharmacy	Hospital Pharmacy; Clinical Trial of Drugs	English, Marxism and Social Science Methodology, Statistics, Academic Ethics and Norms for Graduate Students	Pharmacotherapy; Pharmacoepidemiolog; etc.	Tutorial of APP; Introduction of GCP; The Roles of the CRA; The Roles of Clinical Trial Data Management	APPE; CRA Practice Experiences; Data Management Practice	Evaluation of Drug Efficacy, and Safety; Pharmaco-bioinformatics
Industrial Pharmacy	Drug Synthesis and Process Optimization; Industrial Pharmaceutics; Drug Quality and Process Control		Contemporary Drug Synthesis;Modern Industrial Pharmaceutics; Frontier Technology of Drug Analysis;Drug Standard Practice; etc.	Innovative Drug Research and Development Practices; Pharmaceutical Engineering; Drug Design Monograph; Drug Research and Registration; etc.	Drug Synthesis and Process Optimization Training; Comprehensive Analysis Skills and GMP training	Professional Literature Study and Writing
Pharmacy Management	Management of Pharmacy; International Drug Registration; Regulatory Science		Pharmaceutical Management and Regulations; International Drug Registration; Drug Regulatory Science; etc.	Health Systems and Policies;Pharmaco-economics Application;Frontier Regulatory Science; Drug Quality Management; etc.	GMP Practice; Drug registration in Europe and America; Drug Regulation Science	Pharmaco-economic Application; Drug Innovation Pathway

APP: advanced *pharmacy* practice; APPE: advanced *pharmacy* practice experiences; GCP: good clinical practice; CRA: Clinical Research Associate; GMP: Good Manufacturing Practice

discipline. The course selection is based on the premise of not breaking the internal links of the discipline, which means the course content is organized according to the logic of the discipline knowledge.

The teaching methodology in the M. Pharm. education program

In China, the classroom didactic lecture still occupies the dominant position, but it is gradually becoming more flexible and diversified. The dominant method has changed from teacher-centered to student-centered where more novel teaching methods including case study, group discussion, problem-based learning (PBL), flipped classroom, Micro-Lectures and Massive Open Online Courses (MOOCs), and simulation training are used. The application of the new teaching methodologies lets students learn knowledge and skills during a limited period and at the same time obtain the ability of lifelong learning. In addition, The NSCPDP encourages the submission of excellent teaching cases every year and recommends them to the China Professional-Degree Case Center,[11] which effectively supports case teaching in the M. Pharm. degree courses.

Professional practice in M. Pharm. education

The aim of M. Pharm. education is to develop high-level applied pharmacy expertise. Therefore, all schools or universities attach great importance to the training of practical application ability. Following theory courses, the basic skills of scientific research is taught in the second semester as a preparation for professional practice and thesis research. Students generally start professional practice in the second year. The training guide issued by NSCPDP clearly requires that the students' practice time should not be less than one year and the entire practice training account for nearly 20% of the total credits. Students practice at the specific training site designated by the training institutions. The practice places and educational contents vary among the different fields of training (Table 2). The professional degree education of pharmacy in the United States, Japan, and other countries focuses on clinical service. In China, the M. Pharm. Education program develops mainly general pharmaceutical expertise and the practice covers areas such as pharmaceutical production, research and development, management, and service. Regarding practice location, M. Pharm. students mainly train in pharmaceutical enterprises, pharmaceutical regulatory departments, affiliated or clinical teaching hospitals (First-Class hospitals), or scientific research institutes. According to the survey of 113 training sites conducted by the secretariat of the NSCPDP in 2021,

Table 2: The practice site and practice content of M. Pharm. in China.

Training Field	Schedule	Practice Site	Practice Content
Industrial Pharmacy	Carry out the combination of concentrated and segmented practice, requiring no less than one year of practice.	Pharmaceutical Enterprises; Scientific Research Institutes; Pharmaceutical Inspection Departments	Production and Technology Improvement; Drug Research and Development and Transformation; Drug Production Management
Clinical Pharmacy		Tertiary Hospital A; CRO Company	Prescription Dispensing; Clinical Rounding with Specialized Clinical Pharmacists; Design of Individualized Regimen Based on TDM and Pharmacogenomics; Medication Information Service
Pharmacy Management		Drug Regulatory Departments; Examination and Approval Departments; Inspection Departments and Pharmaceutical Enterprises	Drug Registration and Declaration; Drug Promotion and Circulation; Drug Supervision; Pharmaceutical Enterprise Management

1236 training sites have been established in cooperation with enterprises and public institutions. This includes pharmaceutical enterprises, medical institutions, government departments, and public institutions among which pharmaceutical enterprises account for 57.52% and have provided 9,971 students with opportunities for professional practice.[8] By the end of 2020, experts invited by the NSCPDP selected twenty national M. Pharm. training demonstration sites as models of the joint training bases for outstanding graduate pharmacy students. Furthermore, to develop high-level application-oriented expertise with an international vision, some universities have cooperated with abroad enterprises to establish overseas training sites. For example, by taking the lead in establishing many overseas practice sites for M. Pharm. graduate students, CPU has created opportunities for international joint training and has developed new channels that promote international innovation ability and competitiveness.

Faculty in M. Pharm. education

A double-mentor system is implemented in the M. Pharm. education program which means each graduate student is provided with two mentors, one on-campus and one off-campus. On-campus supervisors take the major responsibility and are qualified faculty members for graduate students. They are not only fully responsible for the students' theoretical courses and academic guidance but also maintain communication with off-campus mentors from beginning to end to supervise students to successfully complete their off-campus practical work and graduation research project. Off-campus mentors are recommended by the joint training sites and approved by the university. They are specific instructors for graduate students at the off-campus practice sites and are responsible for the guidance of the entire practical teaching and research programs. Colleges or universities create scientific research platforms for students, while practice sites create professional practice platforms for students. The resource advantages of both promote the ability of students to achieve the training goal of the M. Pharm. program. The selection of off-campus mentors emphasizes practical experience in pharmacy and requires a doctoral degree or associate senior title (or position) with several years of work experience. Unfortunately, at present, most off-campus mentors are unfamiliar with graduate education and are lacking teaching experience. Therefore, colleges or universities have programs to train the off-campus mentors via unified teaching, discussion and exchange, and academic discussion to improve their teaching ability.

Statistics from the secretariat of the NSCPDP in 2021 showed that there are total of 3,926 on-campus supervisors in the 113 institutions with an average age of 45.8 years. 90.77 percent of the supervisors holds a Doctor degree, 95.1 percent have obtained the title of associate senior or above, and 53.29 percent have more than one year of overseas study experience. The 113 training sites have 3,067 off-campus mentors (part-time) with an average age of 47.1 years. They have titles or positions such as senior engineer, chief pharmacist, and technical director. Apart from full-time professors in colleges or universities that teach the theoretical courses of the M. Pharm. program, off-campus mentors with practical experience also participate in the theoretical course teaching, which strengthens the integration of theoretical knowledge and practice.

Quality assurance and evaluation for M. Pharm. education

In China, the graduate school and the teaching department work together to assure the internal quality of graduate education of pharmacy via a

supervisor's responsibility system. Under the guidance of the Academic Degree Evaluation Committee in the university, the graduate school and the teaching department are responsible for all training and curriculum design for the students. The internal quality assurance system of the M. Pharm. education program mainly includes course assessment, practice assessment, thesis proposal, mid-term assessment, and thesis defense, among which the practice assessment is the key to examine the training quality of M. Pharm. education. The respective evaluation criteria are different among different professional fields. According to the research results of the survey of the NSCPDP in 2021, different institutions and practice sites jointly set practice criteria for the corresponding training fields. The common requirements of practical skills assessment in various training fields highlight that students should have good organization skills, coordination, and communication ability; they also should have acquired the abilities of literature retrieval, analysis, and promotion. Clinical pharmacy focuses on the assessment of practical abilities such as patient education, medication information service, clinical rounding, evaluation of drug efficacy and adverse drug reaction, and the design of an individualized drug regimen. Assessment of industrial pharmacy practice includes (1) operation standards and safety measurement, (2) basic theory, process and operation specification of common dosage forms, (3) participation in the practice of new technology transformation, (4) independent completion of formulation and revision of scene sampling, and inspection and quality standards, (5) project organization and preclinical research on new drugs, (6) and GMP management implementation and technical renovation. Pharmacy management requires students to be familiar with laws and regulations related to pharmacy, (1) to have the ability to solve practical problems with relative laws and regulations, and (2) to have the ability to apply new drug registration, drug market development, circulation management, post-sales service, and drug information feedback.[12] To assess the student's practical abilities, most medical colleges and universities in China advocate process evaluation or formative assessment. However, a summative assessment is still most often used. At present the use of the formative assessment system in pharmacy education in China is still in an exploratory stage. Therefore, the NSCPDP is actively exploring and evaluating the assessment standards for scientific and normative practical ability.

The external quality assurance and evaluation of the M. Pharm. program can be divided into the supervision by the Ministry of Education (MOE), reviewing thesis quality, and special evaluation of the professional pharmacy degree programs. Supervision by the MOE and thesis sampling inspection are effective ways to ensure the basic quality of graduate training and awarding of degrees. In 2014, the Academic Degrees Committee of the State Council and the MOE issued "the Quality Assessment Methods for Doctoral and Master's Degree Theses" which implemented the assessment of doctoral and master's degree theses nationwide. This quality assurance program is organized by each provincial degree committee and about 5-10% of the theses are sampled. In addition, the Academic Degree Office of the State Council empowers the NSCPDP to conduct a special evaluation on institutions 3 years after their establishment. This includes investigation and qualification assessment of the school's basic conditions, teaching management system, education quality, and other quality indicators for colleges and universities. According to the 2019 MOE education statistics,[13] the overall failure to complete the program rate for graduate students in China is less than 5%.

Degree acquisition

The graduation requirements of the M. Pharm. program includes completion of the theoretical courses (20 credits), practice courses (the practice time is at least one year, 4 credits), other mandatory class hours and credits, and under the guidance of a supervisor, successful oral defense of an approved thesis. Chinese academic degree regulation regards academic degree thesis as the necessary condition of applying for an academic degree. "The Guidance Training Program for Graduate Students of the M. Pharm. Program" emphasized that "The topic selection for the thesis should focus on relevance and practicability. The topic could be a specific study targeting the economic and social benefits of pharmaceutical practice." This largely ensures the "practicality" of the M. Pharm. degree.

Employment direction of M. Pharm. degree graduates

Hospitals and pharmaceutical companies constitute most job providers for M. Pharm. graduates in China. At present, the supply of graduates is less than the demand with a steady increased demand seen in the pharmaceutical industry. According to the information provided by the CPU employment office, for Shenyang Pharmaceutical University, West China School of Pharmacy Sichuan University, and Peking University School of Pharmaceutical Sciences, the recent employment rate for the M. Pharm. graduates is close to 100% with the overall ratio of supply and demand

reaching 1:3~1:4. In 2019, CPU conferred the M. Pharm. degree on 259 students, accounting for nearly 15% of the total number of graduates with the M. Pharm. degree in China, ranking first in the country. The result of a questionnaire sent to CPU M. Pharm. graduates in 2019 showed that the overall employment rate was 97.27%. The top three employers were private enterprises (42.73%), foreign-funded enterprises (29.96%) and medical and health institutions (12.78%) (Figure 2). The top three positions are product manufacturing and R&D personnel (38.17%), healthcare professionals (24.43%), and other professionals (15.27%) (Figure 3). Also, the overall job satisfaction of M. Pharm. graduates was 89.87%, which was higher than the average level of 83.76% for graduates of the university. These results showed that the employment of M. Pharm. graduates is mainly in the areas of product research and development, transforming research results into products, pharmaceutical care, and the manufacturing industry.

DISCUSSION

Since 2005 the Accreditation Council for Pharmacy Education (ACPE) in the United States has required that pharmacy schools or colleges accredited by ACPE must fully implement the Pharm. D. curriculum. The Pharm. D. degree has become the only entry level degree for newly licensed pharmacists in the United States.[14] Despite the fact that the national conditions and health care systems in China are different from that of the United States, the M. Pharm. program in China has adopted many of the characteristics of the Pharm. D. education program in the United States. Compared with the Pharm. D. education program in the United States, the characteristics of the M. Pharm. education program in China are mainly reflected in the following three aspects. First and foremost, both scientific research ability and practical ability are regarded as equally important. Therefore, the thesis for the M. Pharm. degree must include both theoretical and innovative research topics found in practice. The second aspect is the diversity of training fields. The M. Pharm. Education program focuses on training high-level, application-oriented professionals who are competent in drug production, drug distribution, drug use (pharmaceutical care), and supervision of drug handling. Finally, the double-mentor team based on the "project cooperation system" is one of the characteristics of M. Pharm. training mode in China. The NSCPDP vigorously promotes the joint training of graduate students by on-campus and off-campus mentors based on the common practical project cooperation. In the development process of M. Pharm. students, on-campus and off-campus mentors are responsible for the overall guidance of course learning, practice links, subject research, and paper writing through regular periodic communications, which also strengthen the cooperation between the school and the practice base at the same time.

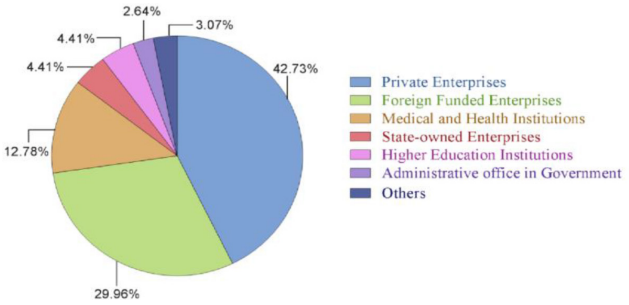

Figure 2: Employment and employer distribution of M. Pharm. graduates in 2019.

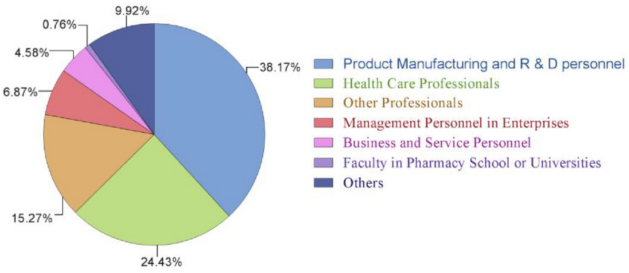

Figure 3: Job distribution of M. Pharm. graduates in 2019.

Current status of M. Pharm. education in China and the barriers it faces

Compared to the United States, Britain, and other developed countries, the M. Pharm. education program in China began late. But after ten years of development, it has witnessed the progression from scratch to existence, from existence to the standard, then to systematization, and it will continue to upgrade with more characteristics in the future.

Although remarkable achievements of the M. Pharm. education have been made in the past ten years, it is not enough to form a perfect system and some deficiencies have been exposed. The challenges of M. Pharm. education in China are mainly reflected in the following five aspects. The first challenge is the lack of a unified and quality scientific accreditation standard. Chinese schools and universities with a M. Pharm. degree program have developed their training programs according to their own specific conditions: teaching situation, teaching methodologies, curriculum setting, and individual practical designs that have resulted

in different levels of quality training. The second challenge is that the practical training and evaluation system requires further improvement. The NSCPDP assessment standards of the quality of practical training are not yet a unified standard, and the management of the practice process in some cooperative training sites is not standardized. These problems have a direct impact on the development of M. Pharm. students and restrict the improvement of the quality of M. Pharm. degree. The third challenge is that there is still a gap in the quality of the professional degree students compared with the regular academic degree students. Constrained by the academic-oriented ideology for a long time, the concept that a professional degree is lower than an academic degree is still widespread in the field of pharmacy education in China. The fourth challenge is that enrollment across various majors affects the quality of M. Pharm. development in China, because the cross-major students have not systematically learned the basic knowledge of pharmacy in their undergraduate studies and are unfamiliar with research methods of new subjects.[15] The fifth challenge is the lack of participation by industry and the relatively closed expertise training model, which has limited the training quality and development level of M. Pharm. education in China. In the process of administering M. Pharm. education, the government, industry, and universities have not formed a unified cooperative operation model due largely to historical reasons. The postgraduate professional degree education of pharmacy is still confined to colleges and universities, while the industry does not participate in the expert training process.

Opportunities and future direction for M. Pharm. education

According to the "2020 Outlook Report on the Development of Pharmaceutical Industry in China",[16] from January to September 2019 the pharmaceutical industry achieved a total gross income of 2017.26 billion yuan with a total profit of 267.52 billion yuan. The industrial added value increased by 7.8% year-on-year, accounting for 3.6% of the total industrial value. It is expected that the added value of the Chinese pharmaceutical industry will maintain a growth rate of around 8-10% in 2020, and the proportion of industrial added value is expected to further increase to 3.7%. Therefore, it is urgent to develop M. Pharm. education in China to ensure the sustainable development of the Chinese pharmaceutical industry. To promote the development of postgraduate professional degree education of pharmacy in China, the government, industry, and universities should take the following actions. First, the China Academic Degrees and Graduate Education Development Center (CDGDC) as a third-party organization between government and university, have started appraisal of the M. Pharm. degree education in the second half of 2020. Taking different dimensions such as teaching quality, learning quality, and quality of career development into considerations, CDGDC will investigate the quality of graduate students with M. Pharm. degree by schools or universities, and the final results will be published according to the principle of "accurate calculation of level score and classification of grades" in 2022. According to the appraisal results, the standard of education quality will be further improved. Secondly, industrial collaboration with the concept of industry-education-research-hospital cooperation should be promoted. For example, CPU uses the "5-together" model in M. Pharm. Training. In this model universities, industry, and hospitals "recruit students together make training plans together, teach together, set up teaching teams together, and monitor quality together." This opens new ways to train graduate students in the M. Pharm. education program. Lastly, the types of training and the scale of professional degree pharmacy education in China should be expanded and enriched. Because there is no Professional Pharmaceutical Doctor (PPD) program in China, the NSCPDP has organized a panel of experts to demonstrate the potential value of the PPD degree and now is making application to the MOE for permission to establish a PPD degree program in China. The purpose of PPD education is to train high-level applied experts who not only have the theoretical basis and comprehensive application skills of "the new pharmaceutical sciences", but also have the independent ability to solve complex problems in the field of pharmaceutical practice. "Practicality" is the basic value orientation of the proposed PPD degree in China, and its proposed level is higher than the Pharm. D. degree in the United States.

In the face of the advanced experience of foreign developed countries, in China we should innovate vigorously by combining Chinese conditions with the experience of developed countries, rather than blindly copying foreign models. The future direction for reform of professional graduate degree education of pharmacy in China can be summarized as follows: (1) promote and deepen the recognition of professional degree education of pharmacy and to improve the quality of students; (2) formulate a unified educational certification standard for the M. Pharm. degree, then promote the steady improvement of the quality of education. (3) Further clarify the role of pharmacy

professional degree education, and strengthen the practice of pharmacy depends on practice-oriented and correspond to the demand of market forces; (4) expand the scale of professional graduate degree education of pharmacy. The expansion of the scale of education not only refers to the expansion of enrollment but also includes the expansion of off-campus mentors and industry participation. We believe that these directions should improving the top-level design of the M. Pharm. program.

CONCLUSION

In the past ten years the professional graduate degree education of pharmacy in China has developed rapidly. The number of schools or universities authorized by the MOE to set up M. Pharm. education programs and the enrollment of M. Pharm. students has increased year by year. The proportion of M. Pharm. students of the total enrollment of graduate students continues to increase. The professional graduate degree education in pharmacy has become an important part of the pharmacy education system in China. In the process of development, M. Pharm. education not only draws lessons from foreign advanced experience in the administration of schools or universities, but also has formed its own Chinese characteristics and emphasis in the meantime. Although there are some deficiencies in the development of professional graduate degree education of pharmacy in China, it has a bright future through a strong program of continuous improvement.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

M. Pharm.: Professional master of pharmacy; **MOE**: Ministry of Education of the People's Republic of China; **NSCPDP:** Chinese National Steering Committee for the Professional Degree of Pharmacy Graduate Education; **CPU:** China Pharmaceutical University; **ACPE:** Accreditation Council for Pharmacy Education; **CDGDC:** China Academic Degrees and Graduate Education Development Center; **PPD:** Professional Pharmaceutical Doctor.

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PICTORIAL ABSTRACT

SUMMARY

This study reviewed the development of professional master of pharmacy (M. Pharm.) education program in China in the past ten years. The author consulted a lot of literature, made a questionnaire survey by the Chinese National Steering Committee for the Professional Degree of Pharmacy Graduate Education, and obtained employment-related data for the graduates of China Pharmaceutical University. The result shows that the M. Pharm. education program in China has made remarkable achievements, but faces some challenges. It has a bright future through continuous optimization and further improvement.

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