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Impact of the curriculum system on the quality of stomatology graduates: a multivariable analysis

Zhihuan Liu^{1†}, Ming Zhang^{1†}, Shanshan Pei^{1†}, Lingxian Bao^{1†}, Shuchen Xu^{1†}, Qingyuan Song¹, Weijie Tao¹, Pei Zheng^{1,2}, Jianying Feng^{1,2*} and Shuhua Wang^{1,2*}

Abstract

Background The curriculum system is a central component in achieving the goals and specifications of talent training schemes. However, problems and difficulties exist in curriculum provision due to a lack of curriculum system design logic. This study aimed to investigate the correlation between the university curriculum system and graduate quality and to reveal the design logic of the curriculum system.

Methods A total of 699 stomatology graduates from a university in Zhejiang were selected as research subjects from 2015 to 2022. The students' curriculum system and graduate quality data were collected and classified. The graduate quality information contained (1) the National Board Dental Examination (NBDE) pass rate and score, (2) the postgraduate entrance rate and destination, and (3) the employment rate and work institution. Regression analysis was also conducted to assess the correlation between the curriculum system and graduate quality.

Results Regression analysis revealed significant associations between general education, specialization, and stomatology X courses and NBDE score, postgraduate entrance rate and destination, and work institution. All courses except public elective courses had significant impacts on NBDE score. General basic, medical English, and employment guidance courses significantly influenced the postgraduate entrance rate and destination. Restricted elective and public elective courses had significant effects on employment rate and work institution.

Conclusions Increasing the quality of specialized and stomatology X courses in the curriculum system is beneficial for deepening graduates' expertise and enhancing their education. Moreover, English courses are suggested to be offered in the early stage to lay a better language foundation.

Keywords Curriculum system, Graduate quality, Teaching innovation, Higher education, Stomatology, Regression analysis

[†]Zhihuan Liu, Ming Zhang, Shanshan Pei, Lingxian Bao, Shuchen Xu contributed equally to this work.

*Correspondence:

Shuhua Wang
wangshuhua101@163.com

¹School of Stomatology, Zhejiang Chinese Medicine University, Hangzhou, Zhejiang 310053, China

²Stomatology Hospital affiliated with Zhejiang Chinese Medicine University, Hangzhou, Zhejiang 310053, China



Background

A talent training scheme includes education targets, ability requirements, training features, curriculum systems, training links, examinations and assessment methods, which lay the foundation of talent training and quality evaluation [1] [Fig. 1]. The curriculum system is the central component of training scheme and is designed to achieve the goals and specifications of professional personnel training. However, it is difficult for curriculum provisions to match objective talent cultivation, resulting in poor teaching efficiency. Foundational and specialized courses, theoretical and practical courses, etc., do not adhere to educational principles and disrupt logical progression from basic to advanced levels. Improper course provision could result in weak foundational discipline, inadequate clinical skill practice, and insufficient knowledge depth [2]. Compared with developed countries, China’s cultivation quality of stomatology talent might not accurately meet the demands of the medical industry [3]. In addition, in accordance with international standards, the current era emphasizes talent cultivation via “medicine+X” knowledge and introduces new requirements for higher medical education in China. The necessary dentist competencies in the future involve expert judgment as well as a high level of professionalism and ethics in order to handle complex issues that are beyond the capabilities of AI and algorithmic care [4].

Various medical universities employ diverse methods and criteria to identify “ideal” candidates. For instance, some studies evaluate education quality via uniform factors, such as school admission rate, Medical College Admission Test (MCAT) score, grade point average (GPA), full-time teacher–student ratio, and National Institutes of Health (NIH) funding [5, 6]. Nevertheless, medical education measurement is regarded as challenging due to its complex evaluation elements. Generally, regardless of humanistic quality, according to the outcome-based education (OBE) model [7], stomatology graduates’ workforce entrance rate, postgraduate entrance rate and National Board Dental Examination

(NBDE) score are considered three key points. First, an ideal job is to fulfill the primary condition for existence and development. Thus, the employment rate and work institution have emerged as core indicators for evaluating talent cultivation [8]. Second, with the urgent demand for high-quality talent in medical areas [9], coupled with their competitiveness, postgraduate entrance examinations have become increasingly essential for those seeking their ideal job. Research indicates that postgraduate entrance is a strong predictor of medical education quality [10, 11]. Third, the NBDE assesses whether applicants possess the requisite professional knowledge and skills, which functions as a crucial benchmark for assessing the teaching quality of medical universities in the health industry.

The curriculum system is the expression of learning and teaching designs in practice [12]. A rational curriculum arrangement boosts learning, facilitates feedback formation in teaching, and promotes the evaluation of learning and performance [13]. Currently, there are few reports on the correlation between curriculum systems and talent cultivation, especially in the field of stomatology. This might lead to empiricism in curriculum establishment. This study aims to (1) reveal the correlation between the university curriculum system (general education, general basic, specialized, restricted elective, public elective, medical English, stomatology X and employment guidance courses) and graduate cultivation quality (NDBE, postgraduate entrance and employment status) and (2) provide a conceptual framework for future improvements in undergraduate stomatology training schemes.

Methods

Research subjects

A total of 699 stomatology graduates from Zhejiang Chinese Medicine University were selected from 2015 to 2022. The students who graduated during this time were included as subjects, those who did not receive a degree or diploma were excluded. The curriculum systems were

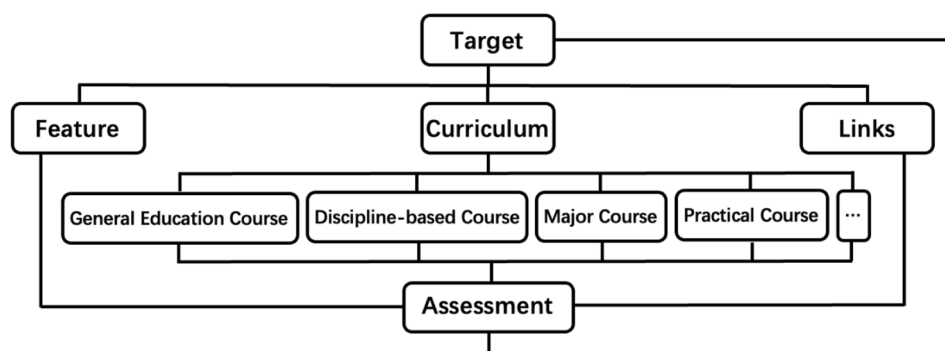


Fig. 1 Talent training scheme composition

disassembled according to the teaching objectives and learning requirements. Information on the NBDE, post-graduate entrance and employment status of the participants was collected [Fig. 2]. All data were obtained from the Academic Affairs Office, Zhejiang Chinese Medical University.

Disassembled curriculum system

Based on Chinese educational policy and situation, the curriculum system of Chinese higher medical education generally contains five modules general education, general basic, specialized, restricted elective and public elective courses. In addition, according to the requirements for stomatology, “medical English”, “stomatology X” and “employment guidance” are incorporated as constituent modules. Thus, this study disassembled the curriculum system into eight modules and counted the number and

proportion of class hours of each module respectively (Table 1).

1. *General education courses* (Ethics and Fundamentals of Law, Situation and Policies, Computation, PE and so on).
2. *General basic courses* (Professional Introduction, Human Anatomy, Physiology, Histology and Embryology, Pharmacology, Surgery, Internal Medicine and so on).
3. *Specialized courses* (Oral Anatomy and Physiology, Oral Histology and Pathology, Orthodontics, Prosthodontics, Cariology and Endodontics, Periodontics, Diseases of the Oral Mucosa, Oral and Maxillofacial Surgery and so on).
4. *Restricted elective courses* (Advanced Mathematics, Medical Physics, Microbiology and Immunology,

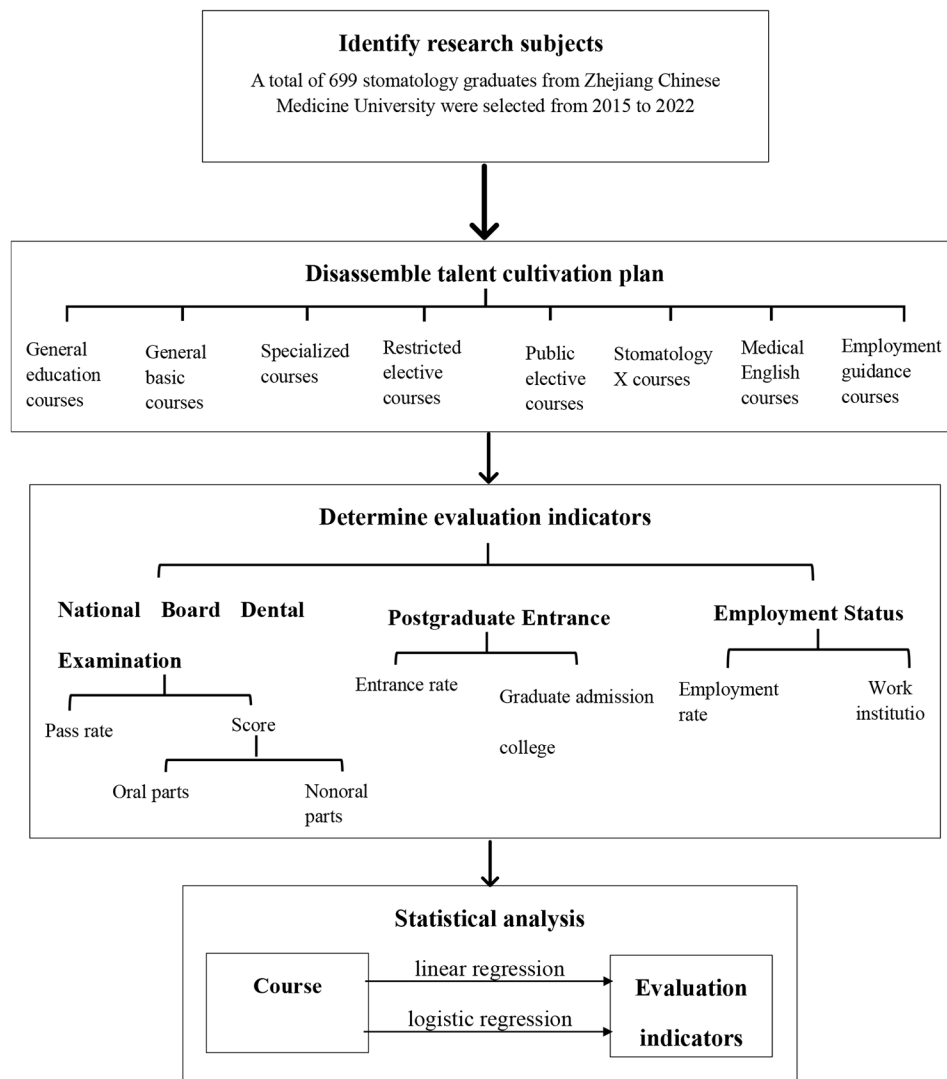


Fig. 2 Research roadmap

Table 1 The stomatology curriculum system from 2015 to 2022

Grade/Course	General Education	Proportion	General	Proportion	Specialized Courses	Proportion	Restricted Elective	Proportion	Public Elective	Proportion	Stoma-tology X English	Medical English	Employ-ment guidance
2015	748	21%	1174	33.00%	587	17%	646	18%	374	11%	0	1	34
2016													
2017	833	23%	757	24.00%	724	22%	646	20%	374	11%	179	0	51
2018													
2019													
2020	815	21%	774	20.00%	724	19%	1148	30%	374	10%	111	0	51
2021	510	16%	1046	32.88%	792	24.90%	629	19.77%	204	6.41%	238	1	34
2022													

The number of course hours and graduate proportion from 2015 to 2022 are listed

- Medical Psychology, Medical Statistics, Epidemiology and so on).
- 5. *Public elective courses* (students are free to choose and earn the required credits).
- 6. *Stomatology X courses* (Oral Aesthetics, Clinic Management, Oral Aesthetics Photography, Experimental Technology, Oral Digital Information Technology).
- 7. *Medical English courses* (courses offered to freshmen and sophomores = 0, offered at the junior and senior levels = 1.)
- 8. *Employment guidance courses* (Career Guidance for Graduates, Student Venture Guidance, Career Planning).

Measurement of the evaluation indicators for talent cultivation quality

With respect to the OBE model, this study investigated graduates' situations in view of their direction of dentist development. Six evaluation indices were selected from three aspects: (1) NDBE, (2) postgraduate entrance and (3) employment status [Table 2].

1. National Board Dental Examination.

- 1.1 The NBDE includes the results of the physician qualification examination (failure = 0, pass = 1) and.
- 1.2 The score on the theoretical test (oral and nonoral parts).

2. Postgraduate Entrance.

- 2.1 Postgraduate entrance included the following components: the results of postgraduate entrance (failure = 0, success = 1) and.
- 2.2 The graduate admission college destinations (failure = 0, ZCMU and other domestic colleges = 1, overseas colleges = 2, 985 211 colleges = 3).

3. Employment Status.

- 3.1 Employment status included the employment result (unemployed = 0, employed = 1) and.
- 3.2 The work institution (waiting for employment = 0, clinics, community health centres, and maternal and child health centres = 1, outpatient clinics and hospitals = 2, medical management and health administration = 3, and advanced education = 4).

Table 2 Evaluation indicators

Evaluation Indicators		Variable Explanation
National Board Dental Examination	Pass rate	0= failure 1= pass
	Theoretical test	score on oral part score on nonoral part
Postgraduate Entrance	Entrance rate	0= failure 1= success
	Graduate admission college	0= failure 1= ZCMU and other domestic college 2= overseas college 3= 985 211 college
Employment Status	Employment rate	0= unemployed 1= employed
	Work institution	0= waiting for employment 1= clinics, community health centres, maternal and child health centres 2= outpatient clinics, hospitals 3= medical management, health administration 4= advanced education

Table 3 Comparison of research subjects in different grades

Grade	2015	2016	2017	2018	2019	2020	2021	2022	P
National Board Dental Examination Pass Rate	83.87%	84.00%	83.33%	80.00%	94.34%	83.64%	82.00%	-	0.209
Postgraduate Entrance Rate	7.58%	19.70%	16.42%	27.84%	20.43%	24.44%	19.01%	27.55%	0.061
Employment Rate	93.00%	97.00%	95.80%	98.00%	100.00%	92.90%	92.56%	94.40%	0.068

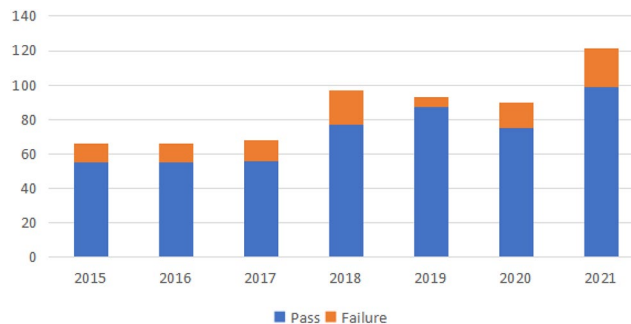


Fig. 3 National Board Dental Examination pass rate from 2015 to 2022

Statistical analysis

Data processing was performed using SPSS 26.0 statistical software. There was no statistically significant difference ($p > 0.05$) in National Board Dental Examination pass rate, postgraduate entrance rate or employment rate among the study participants in different grades [Table 3]. Regression analysis was applied to investigate the correlation between curriculum provision and graduate quality. Linear regression was employed when the dependent variable was continuous, while logistic regression was used for categorical data. A significance level of 5% ($p < 0.05$) was used for all tests.

Results

The NBDE pass rate consistently exceeded 80% from 2015 to 2022, which was greater than the national average throughout the seven years. The postgraduate entrance rate was approximately 20%, while the employment rate surpassed 90% [Figs. 3, 4 and 5]. Univariate analysis revealed significant associations between general education, specialized, and stomatology X courses and NBDE score, postgraduate entrance rate and destination, and work institution. In addition, all courses except public elective courses had significant impacts on NBDE score. General basic, medical English, and employment guidance courses significantly influenced the postgraduate entrance rate and destination. Restricted elective and

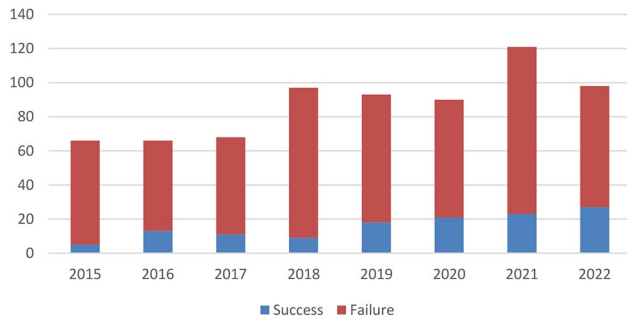


Fig. 4 Postgraduate entrance rate from 2015 to 2022

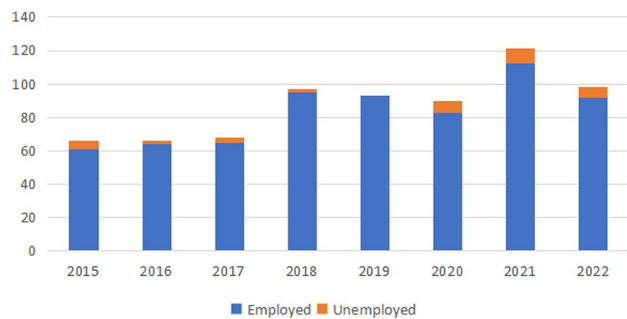


Fig. 5 Employment rate from 2015 to 2022

Table 4 Correlations of scores on the oral part of the NBDE

Independent variable	B	SD	Beta	T	P
General Education Courses	0.158	0.024	0.324	6.508	<0.001
General Basic Courses	-0.034	0.005	-0.35	-7.084	<0.001
Specialized Courses	0.103	0.014	0.355	7.2	<0.001
Restricted Elective Courses	0.03	0.006	0.276	5.441	<0.001
Stomatology X Courses	0.069	0.012	0.293	5.822	<0.001
Medical English Courses(1)	-14.131	1.963	-0.355	-7.2	<0.001
Employment Guidance Courses	0.831	0.115	0.355	7.2	<0.001

Table 5 Correlation of the scores on the nonoral part of the NBDE

Independent variable	B	SD	Beta	T	P
General Education Courses	-0.119	0.036	-0.171	-3.284	0.001
General Basic Courses	0.025	0.007	0.179	3.459	0.001
Specialized Courses	-0.075	0.022	-0.181	-3.492	0.001
Restricted Elective Courses	-0.017	0.008	-0.109	-2.086	0.038
Stomatology X Courses	-0.053	0.017	-0.159	-3.051	0.002
Medical English Courses(1)	10.331	2.959	0.181	3.492	0.001
Employment Guidance Courses	-0.608	0.174	-0.181	-3.492	0.001

public elective courses had significant effects on employment rate and work institution.

National board dental examination

The scores on the oral and nonoral parts of the NBDE were significantly influenced by all course provisions in terms of the theoretical tests except for public elective courses ($p < 0.05$), among which medical English courses had the greatest impact. In detail, general education,

specialized, restricted elective, stomatology X and employment guidance courses significantly increased score on the oral part, and general basic courses and medical English courses in upper grades(the junior and senior level)were negatively correlated [Table 4]. In the nonoral part, the results were reversed [Table 5]. There was no significant difference in the impact of any of the courses on the NBDE pass rate ($p > 0.05$) [Table 6].

Postgraduate entrance

The postgraduate entrance rate was significantly different in terms of general education, general basic, specialized, stomatology X, medical English, and employment guidance courses ($p < 0.05$). Among them, general education, specialized, stomatology X, medical English, and employment guidance courses were positively associated with a higher rate, while general basic courses were associated with a lower rate. Medical English (OR=2.25) and employment guidance courses (OR=1.049) had the greatest impact [Fig. 6]. Graduate admission college differed in terms of general education, general basic, specialized, stomatology X, medical English and employment guidance courses ($p < 0.05$). Furthermore, general basic courses and medical English courses in lower grades were positively correlated with domestic college admission, while general education, specialized and employment guidance courses were negatively correlated. Stomatology X was positively correlated with ZCMU postgraduate admission (OR=1.004). There was no significant difference between curriculum provision and overseas college admission ($p > 0.05$) (Fig. 7).

Employment status

The employment rate significantly differed in terms of restricted elective, public elective, and stomatology X courses ($p < 0.05$). Among them, restricted elective and stomatology X courses were negatively correlated with the employment rate, whereas public elective courses were positively correlated [Fig. 8]. The results showed that restricted elective courses played a negative role in medical work institution employment ($p < 0.05$). In addition, general education, specialized, restricted elective and stomatology X courses had meaningful impacts on postgraduate education ($p < 0.05$). Additionally, general education, specialized and stomatology X courses positively affected advanced education, while restricted elective courses were negatively correlated with advanced education [Fig. 9].

Discussion

Overall, graduate quality has been evaluated by multi-dimensional evaluation indicators, especially the NBDE pass rate and employment rate. On the one hand, these findings prove that ZCMU has relatively high talent cultivation quality and is a valuable curriculum system.

Table 6 Summary table of correlations

Correlation	General Education Courses	General Basic Courses	Specialized Courses	Restricted Elective Courses	Public Elective Courses	Stomatology X Courses	Medical English Courses(0)	Medical English courses(1)	Employment Guidance Courses
NBDE Pass Rate									
Score on Oral Part	0.158	-0.034	0.103	0.03		0.069		-14.131	0.831
Score on nonoral part	-0.119	0.025	-0.075	-0.017		-0.053		10.331	-0.608
Postgraduate Entrance Rate	0.01	-0.002	0.006			0.009	0.811		0.048
Destination college	1	-0.011	0.002	-0.007		0.004	0.79		-0.06
	2								
	3	-0.018	0.004	-0.011			0.825		-0.089
Employment Rate					-0.003	0.007	-0.014		
Work institution	1				-0.003				
	2				-0.003				
	3								
	4	0.013		0.006	-0.002		0.008		

All the significant associations ($p < 0.05$) between independent variables (curriculum system composition) and dependent variables (graduate quality evaluation indicators) are listed. The numbers indicate the direction and degree of the association

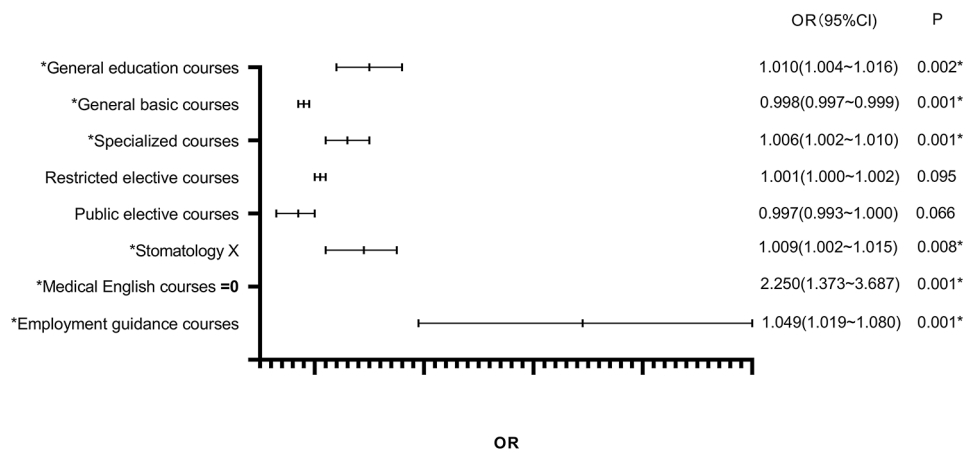


Fig. 6 Correlation between postgraduate entrance and curriculum provision

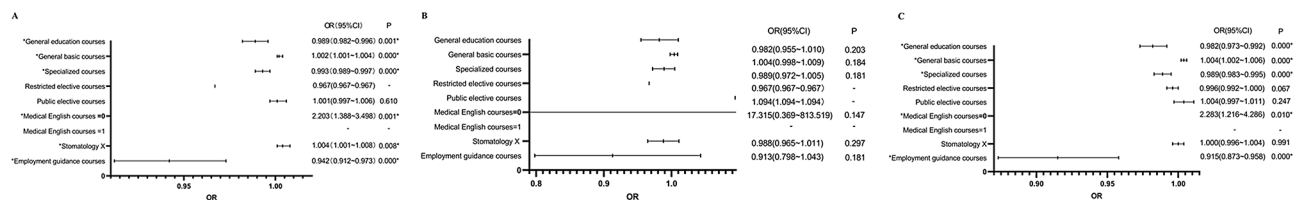


Fig. 7 Correlation between postgraduate admission college and curriculum provision (a) Admitted to ZCMU + other colleges (b) Admitted to overseas colleges (c) Admitted to 985 and 211 colleges

ZCMU stomatology graduates have sufficient ability to undertake clinical work, obtain compensation and realize their professional value. On the other hand, these findings indirectly indicate the booming development of the dental industry based on top student resources, which benefits the NBDE and employment. The postgraduate admission rate is lower. This might be because traditional curriculum provision focuses only on filling knowledge

gaps and neglects students' mind cultivation. As a result, although students have sacrificed enormous amounts of time in memorizing textbooks, most of them lack the capacity to think critically, justify decisions, and use logical reasoning to analyse problems. Students have better learning effectiveness if they can integrate information to understand content taught by seeking meaning, relating ideas, and using evidence rather than rote learning [14].

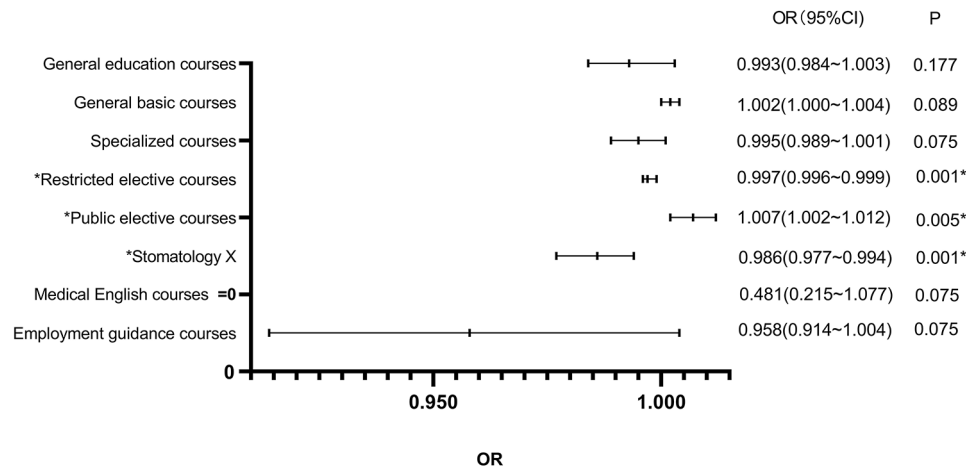


Fig. 8 Correlation between employment rate and curriculum provision

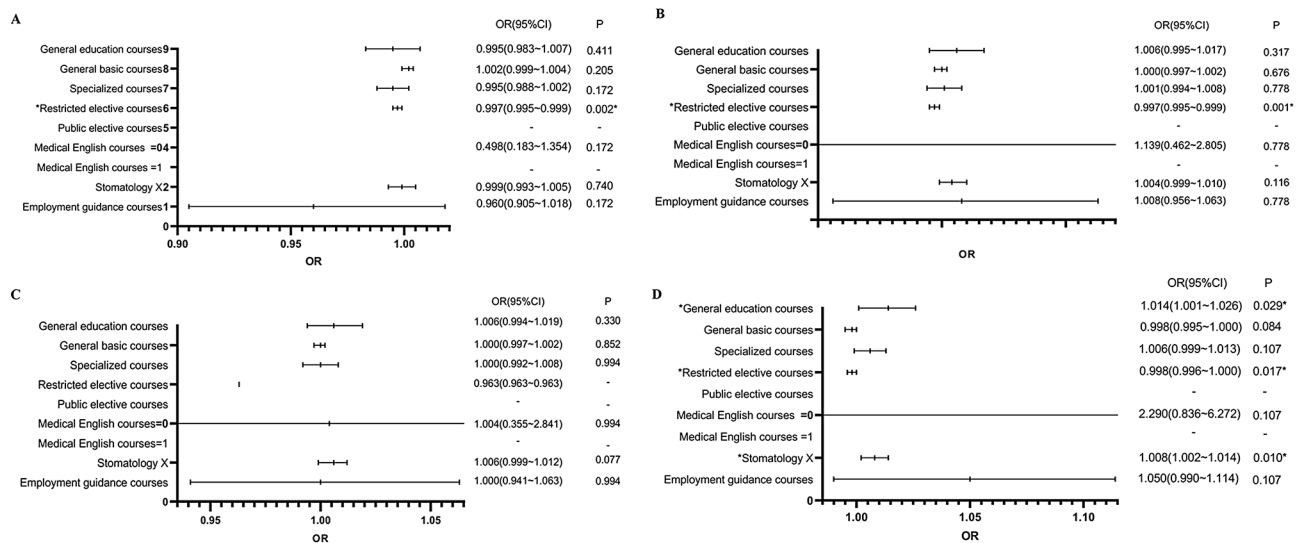


Fig. 9 Correlation between work institution and curriculum provision **A** Employment in clinics, community hospitals and maternal and child health care hospitals **B** employment in outpatient clinics and hospitals **C** Employment in medical management and health administrative management **D** Advanced education

In the present study, we found that specialized and stomatology X courses were positively related to the NBDE oral score, which indicates that increasing the number of class hours dedicated to specialized and stomatology X courses can improve the oral score and the NBDE pass rate. The better exam performance may be partially explained by greater clinical exposure in the curriculum early on, where, i.e., the first 2 years at the University of Missouri-Columbia are utilized for early clinical exposure and basic science education [15]. However, this is difficult to achieve due to the contradiction between infinite medical knowledge and the limited number of school hours. The current undergraduate stomatology education in China adopts the three-stage teaching mode of basic medicine—clinical medicine—stomatology [2]. The establishment of numerous clinical medical courses has

led to an obvious shortage of basic and clinical stomatology courses and insufficient professional skills training [16–18]. For the nonoral portion of the NBDE, general basic courses are positively correlated with the score, indicating that increasing the number of class hours in basic clinical courses improves students’ comprehensive medical quality and ability. The learning stage of clinical medicine is considered to be characterized by higher cultivation of stomatology talent in China, and emphasis is placed on medical students first and stomatology students second [19]. Therefore, how to balance stomatology courses and clinical courses is an urgent problem. It is suggested that school years be extended by referring to the training model of developed countries and that theoretical and practical courses be cross-matched throughout the whole education process [20–22]. Accumulating

clinical experience in advance leads to a smoother transition [23–25] and a lighter cognitive load [26].

In the present study, medical English (OR=2.25) and employment guidance courses (OR=1.049) had the greatest positive impacts on the postgraduate entrance rate. This is because postgraduate entrance examination subjects are divided into ideological and political theories, specialized courses and foreign languages. Medical English courses improve students' foreign language skills. Moreover, when selecting students, graduate tutors often require English interviews throughout the process to test the student's English level. For medical students, mastering medical English is an advanced skill for medical treatment, scientific research and related activities in future professional research or work [27]. However, studies have noted that students who grow up in non-English-speaking countries are limited by language and expertise in reading English literature [28, 29]. It is suggested that medical English courses be offered in the early stage to help individuals learn and improve their English throughout their education and lay a solid language foundation. Employment guidance courses help students clarify industry academic requirements and strengthen their confidence in taking postgraduate entrance examinations [17]. General basic courses are positively correlated with admission to domestic colleges, which indicates that increasing class hours is conducive to improving students' comprehensive medical literacy and admission opportunities at domestic universities. The stomatology X course was positively correlated with admission to ZCMU for postgraduate studies (OR=1.004), possibly because stomatology X courses enhance students' comprehensive ability and professional teachers' appreciation of students.

In the present study, it was observed that restricted elective and stomatology X courses were negatively correlated with the employment rate. Restricted elective and stomatology X courses are extended courses that impose greater requirements on students. Therefore, as class hours increase, students are more inclined to pursue advanced education, which is negatively correlated with the employment rate. Restricted elective courses were negatively correlated with medical institution and advanced education. This might be because the main restricted course at ZCMU is Chinese medicine, which is not the vital helpful for employment of stomatology students. General education, specialized and stomatology X courses are positively correlated with advanced education, indicating that a solid professional foundation; high-quality stomatology X composite talent training courses; and necessary language, humanities and social science general education cultivate students' lofty value pursuits and career beliefs. Professional teachers encourage students to pay attention to advanced knowledge and the

latest technology in professional fields to follow or even lead the progress of disciplines.

Similarly, in the present study, there was a negative correlation between specialized courses and postgraduate admission to domestic universities. Public elective courses were positively correlated with the employment rate. The specific reasons are still unknown, and further investigations and statistics are still needed.

In addition, there was no significant difference in admission to overseas colleges across the curriculum settings, possibly due to the small number of applicants. Employment guidance courses had no statistically significant effect on the employment rate, possibly because current employment guidance courses lack discipline pertinence in design and industry-wide perspectives in stomatology, making it difficult for them to provide operable guidance and support.

In general, in this study, we discussed the logic of curriculum system establishment and performed a preliminary quantitative evaluation of talent quality. It is suggested to appropriately increase specialized and stomatology X courses, reveal the trend of extended school years. However, this study has several limitations. In the process of talent training, we focused only on curriculum establishment and ignored the impact of important training links such as probations and internships, may lead to the evaluation results distortion.

Conclusions

The present study reveals potential correlation between the university curriculum system composition and graduate cultivation quality. Results show that (1) appropriately increasing the quality of specialized and stomatology X courses is conducive to deepening graduates' expertise and expanding the channel for further study, (2) English classes are suggested to be offered in the early stage to lay a better language foundation. Those propositions provide a conceptual framework for future stomatology curriculum system construction. In further study, career satisfaction and happiness are suggested to analysis via professional career satisfaction scale. The talent training quality should be evaluated in multiple dimensions.

Abbreviations

ZCMU Zhejiang Chinese Medicine University
NBDE National Board Dental Examination

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Author contributions

SW conceived the research idea; MZ and SX collected and tabulated the information; ZL performed the data analysis and charted the data; ZL, MZ, and SP interpreted the statistical results; LB contributed to the development of the discussion, and SW critically revised the manuscript. All the authors approved the final version of the manuscript.

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Data availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Zhejiang Chinese Medicine University of Stomatology for studies involving humans. All participants understood and voluntarily provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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