

The Pipeline Model: A Novel Transformative Pathway in the Dental Education Continuum for Saudi Arabia's Strategic Health Workforce Planning Policy: An Exploratory Review

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ABSTRACT The pipeline model, widely used in various sectors, offers a strategic framework for addressing the distribution challenges across sectors. This article proposes a modified pipeline model for dental education to tackle the imbalance between general dentists and specialists, particularly in rural areas of Saudi Arabia. With the recent halt on admissions to a handful of dental colleges and a focus on increasing Saudisation in the workforce, the researchers propose that established dental colleges should enhance postgraduate seat availability in high-demand specialties, while emerging colleges continue to train undergraduates. By aligning postgraduate opportunities with market needs, the model aims to ensure a balanced distribution of dental professionals across urban and rural settings. This approach not only addresses the immediate employment challenges for general dentists but also fosters the development of specialists, thereby enhancing overall dental healthcare across the Kingdom. The proposed model aligns with national educational strategies, promoting a sustainable and equitable dental workforce.

INTRODUCTION

The pipeline or the feeder model has been used in the corporate sector, sports and healthcare. This model has also been adopted in the field of education. The pipeline model can be viewed as a strategic framework or approach for developing, nurturing and advancing individuals through stages to reach the final goal. In the field of education, this would facilitate long term planning by creating a continuous pipeline of talented students to meet the demands of the future goals.

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The World Health Organisation (WHO) has stated that recruitment and retention of healthcare workers in rural areas is a major global problem (WHO 2010). To address this issue, various countries have developed different strategies to suit their national priorities and necessities. The pipeline model has been used in medical education (rural pipeline model) in countries like the United States and Canada. A study conducted in the province of Ontario, Canada has provided evidence that those students educated in rural areas are more likely to establish medical practices in rural areas (Wenghofer et al. 2017). Another study conducted in Alabama has shown that the rural pipeline program reforms the rural areas by retaining 1 family physician out of every 4 students in the pipeline (Mains et al. 2016).

In general, pipeline programs have been shown to be effective in increasing the number of healthcare professionals in underserved areas. The Dental

Pipeline program is aimed to reduce disparities in dental care access by increasing the time students spend in community clinics and recruiting under-represented minority and low-income students (Bailit et al. 2005). Pipeline programs have effectively increased underrepresented student enrolment in medical and dental programs, though evidence quality remains low for strong conclusions (Tombers et al. 2023). In the Saudi Arabian context, a rural pipeline has been strongly advocated in the field of nursing and midwifery (Alluhidan et al. 2020).

A recent study by Alqahtani et al. (2022) among practicing dentists, presented that the distribution of dentists within the Kingdom is more populated in urban areas (Alqahtani et al. 2022). On the other hand, a study conducted among dental interns in Saudi Arabia showed that the interns are ready to work in rural areas if it is closer to their hometown (Khanagar et al. 2020). Thus, there is a need for an urgent solution to tackle this challenging situation for the betterment of dental healthcare within the Kingdom. In this descriptive review, the researchers propose a modified version of the pipeline model in the field of dental education aiming for a proportionate distribution of dentists across rural and urban areas.

Rationale

The pipeline model has been effective in various sectors and can potentially support long-term planning in education by creating a continuous pipeline of talented students. To address the disproportionate distribution of dentists and lack of job opportunities for undergraduate dentists in Saudi Arabia, this article proposes a modified pipeline model for dental education to achieve a balanced distribution across rural and urban areas.

Objectives

The following objectives are proposed to address the challenges and opportunities presented in the introduction section:

1. Propose a framework aimed at achieving a balanced distribution of dentists across rural and urban areas within Saudi Arabia.
2. Outline the potential benefits of this modified pipeline model for improving dental healthcare in rural regions.

Literature Review

Due to the increase in the saturation of the undergraduate dental job market, the General Committee of the Council of Ministers and the Secretariat of the Council for Universities Affairs in the Kingdom of Saudi Arabia (KSA) decided to stop granting licenses to open new dental colleges within the Kingdom until 2033. In March 2024, the Ministry of Human Resources and Social Development of KSA implemented a 35 percent Saudisation of dentist jobs in the private sector (Saudi Gazette Report 2023). This initiative aims to recruit and retain the right Saudi talent, as well as to facilitate their training and qualification (Hazazi 2017). Recently, in July 2024, the Secretariat of the Council for Universities Affairs notified that the total number of undergraduate seats in Bachelor of Dentistry (BDS) program is to be reduced to a total of 400 seats across all the universities in the Kingdom. It was also decided not to allot seats to a handful of dental colleges by barring a new intake of students from the academic year 2025-2026. All these measures were primarily taken to increase the demand for general dentists with undergraduate qualifications.

In a recent study published in 2022, it was shown that the general dentist (with a BDS degree) is more dominant (75%) than specialists (25%) (Alqahtani et al. 2022). This is a very important statistic that shows the severe scarcity of dentists who have a master's degree, are board certified or have a PhD. Specialities such as dental implant, oral radiology, dental public health, oral pathology, and oral medicine are less common across the KSA and nil in some regions. On the other hand, board certified prosthodontists and endodontists are the more prevalent specialities. It is thus clear that there is overproduction of general dentists, coupled with a shortage/under-production of specialists in some specialities and overproduction in other specialities. This accounts for maldistribution not just between general dentists and specialists, but also amongst the specialists by individual speciality. However, with an ever-increasing Saudi population, the number of specialists is currently 1 among 4 dentists in the Kingdom. This poses a serious public oral health challenge in most areas of the Kingdom, especially in rural areas.

To further compound this problem, there is also an acute shortage of the number of postgraduate

seats offered by the Saudi universities. As per the data released by the Saudi Commission for Health Specialities, the number of postgraduate seats across Saudi in the year 2013 is only 316. With approximately 1,950 undergraduate students passing out every year (Fita et al. 2020), only 1/6th of these students stand a realistic chance to pursue post-graduation. This leaves the remaining students (approximately 1,600) each year in a very vulnerable situation and over a period of time leads to scarcity of jobs in the labour market and increase in the unemployment rates of undergraduate dental students within the Kingdom.

METHODOLOGY

Study Type

This is a descriptive exploratory model-based literary search grounded on the theoretical frameworks in order to propose a modified pipeline model in dental education for Saudi Arabia.

Theories and Alignment with the Proposed Model

This novel approach was developed based on the theoretical frameworks that would address the current problem of lack of job opportunities for undergraduate dentists and uneven distribution of dental workforce within the Kingdom. Theories for this narrative review were selected based on their ability to provide diverse, flexible perspectives to explore the underlying factors and patterns within the scope of objectives of this study. The selection of theories for the modified pipeline model in dental education is grounded in the need to address the disproportionate distribution of dentists across rural and urban areas in Saudi Arabia. Workforce development theory aligns the education and training system with the labour market demands (Jacobs and Hawley 2009). The Social Accountability in Health Professions Education framework (Larkins et al. 2013) emphasises the responsibility of education programs to respond to the health needs of the community and society. The Systems Thinking Framework (Kapp et al. 2017) is holistic and it considers interrelated components (education, health policy, labour markets) within a larger system. The Transformative Learning Theory Framework (Apte 2009) focuses on reshaping education to create adaptive and socially

responsive professionals. The Human Capital Theory Framework (Quiggin 1999) emphasises planned investments in education and training to enhance individual and societal productivity. There is no single theoretical framework that would support the current idea and hence, the researchers utilised all the frameworks mentioned above in developing this novel pipeline model.

RESULTS

The application of the theoretical frameworks on the proposed pipeline model is shown in Table 1.

The proposed Pipeline Model for dental education in Saudi Arabia is justified by a strong theoretical framework that addresses key objectives in workforce development, community health, and educational innovation. The Workforce Development Theory ensures a systematic pathway for training dental professionals, while the Social Accountability in Health Professions Education focuses on meeting the healthcare needs of underserved rural areas. The Systems Thinking Framework integrates education, workforce planning, and health policy into a unified strategy, promoting long-term sustainability. The Transformative Learning Theory encourages innovation in educational practices, fostering a shift toward more effective approaches. Finally, the Human Capital Theory highlights the importance of government investment to maximise the societal value of dental professionals, contributing to improved healthcare outcomes. These theories collectively support the model's ability to address current and future dental workforce challenges in Saudi Arabia.

DISCUSSION

This section provides a detailed discussion on the practical application of the deduced model, derived from the theoretical framework, in addressing the current crisis scenario in Saudi Arabia. The pipeline model could provide a potential solution to mitigate this challenge. Traditionally, pipeline models have been used in Western world to address student diversity issues related to underrepresentation of students from certain ethnic and cultural groups (Andersen et al. 2005; Mayrath et al. 2023; Tombers et al. 2023). However, the pro-

Table 1: Matching the theoretical frameworks and the objectives of the proposed novel pipeline model

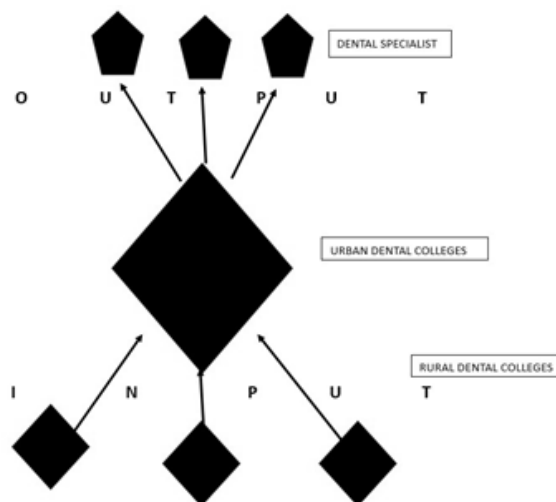
S.No	Theoretical framework	Matching criteria of proposed pipeline model
1	Workforce Development Theory	The focus on the Pipeline Model is to create a systematic pathway for training and deploying dental professionals in Saudi Arabia.
2	Social Accountability in Health Professions Education	The Pipeline Model aims to produce dental graduates who address specific community needs in Saudi Arabia, particularly underserved rural areas. Social accountability also encourages training programs to align with national health priorities.
3	Systems Thinking Framework	The Pipeline Model aims to integrate education, workforce planning, and health policy as a cohesive strategy.
4	Transformative Learning Theory	As this supports critical reflection and innovation in educational practices, the Pipeline Model would be a significant change to the existing dental education approaches.
5	Human Capital Theory	Health workforce planning involves strategic investment by the government to improve societal health outcomes. This Model seeks to optimise the value of dental professionals within Saudi Arabia's healthcare system.

posed model in this study is primarily aimed at the dental workforce redistribution and the proposed roles of rural and urban dental colleges in KSA.

For the purpose of this discussion, it can be regarded that those colleges that have been functioning for more than 15 years are the established dental colleges and the ones that have been functioning for less than 15 years are the emerging dental colleges. The established dental colleges include those dental colleges that are affiliated with

King Saud University, King Abdulaziz University, Imam Abdulrahman bin Faisal University, Qassim University and King Khalid University. All the other dental colleges that are affiliated with universities other than these five universities are the emerging dental colleges (Fig. 1).

The researchers propose that the undergraduate students from rural dental colleges act as an input to the urban dental college whose primary focus should be to increase the number of post-

**Fig. 1. Pipeline model**

graduate seats proportional to the input. This would steadily increase the output of Dental Specialists from the urban dental colleges.

As explained previously, the problem of the employability of the graduates is primarily in the general dentist category and not among the dentists with specialist qualifications (Alqahtani et al. 2025). Using the pipeline model, the researchers propose that the established dental colleges should aim to increase the number of seats for master's, board certified or doctorate degrees, and reduce the number of undergraduate dental students. This increase in the number of seats should be proportional to the market demand of a particular specialty and hence should be managed dynamically. A recent study has shown that oral surgery and implantology specialties have more demand in the labour market (Alqahtani et al. 2022), and hence efforts should be made to increase the number of seats of such specialties in urban dental colleges. As these colleges are already well established, increasing the number of seats would not be a major challenge. On the other hand, the emerging dental colleges, especially those that are established in the rural areas, should continue taking in undergraduate dental students as their primary focus. Thus, the dentists passing out of emerging dental colleges would act as a feeder to the postgraduate programs conducted by the urban dental colleges. This proposed model would solve the issues regarding the disparity in dental professional supply between rural and urban areas (AlBaker et al. 2017; Alqahtani et al. 2022). Thus and so, rural and emerging dental colleges will continue serving the rural community, which still faces a severe scarcity of qualified dentists. With the financial stability, research facilities and faculty strength, the established dental colleges would be able to equip the postgraduate students with skills and competence comparable to the international standards. Proportionate increase of the number of dentists with postgraduate qualification as per the demands of the labour market would effectively increase the job opportunities (Siddiqui et al. 2018). This approach enables the redistribution of output based on job demand in each specialty, promoting a more geographically balanced distribution of general dentists and specialists across rural and urban areas of the Kingdom. It helps prevent the over-concentration of general dentists in urban areas and addresses shortages in rural areas, as gradu-

ates from rural colleges are more likely to remain in rural areas compared to graduates from urban colleges relocating to rural areas.

The proposed model is in line with the University Differentiation Project of KSA wherein universities distinguish themselves from one another based on various factors such as research focused, industrial collaboration focused, teaching focused universities, etc. (Colliers Education Advisory & Valuation Services 2022). This model visualises segregating dental colleges into established and emerging categories which would create a supply chain of high-quality dental graduates for established colleges, if there is a proportionate increase in the postgraduate seats. This creates capacity matching within the system, where there would be an alignment between the number of available seats in a postgraduate program in an urban dental college with the number of qualified undergraduate dental applicants graduating from a rural dental college. Thus, the proposed pipeline model for dental education continuum would effectively mitigate the lack of jobs for general dentists as well as increase the number of specialists across the Kingdom.

CONCLUSION

The proposed pipeline model optimizes dental workforce distribution in Saudi Arabia by aligning education with job market demands. It balances the supply of general dentists and specialists, preventing urban over-concentration and rural shortages. By integrating with the University Differentiation Project, the model enhances postgraduate training in established colleges while supporting rural workforce retention. This structured approach ensures sustainable job opportunities, workforce stability, and improved healthcare access across the Kingdom.

RECOMMENDATIONS

The modified pipeline model for dental education presents a strategic solution to the current imbalance between general dentists and specialists in Saudi Arabia. By increasing postgraduate seat availability in high-demand specialties at established dental colleges in urban areas and focusing undergraduate training at emerging institutions in rural areas, this model addresses both immediate employment challenges and long-term

workforce needs. This approach not only ensures a more equitable distribution of dental professionals across urban and rural areas but also aligns with national educational strategies aimed at fostering a sustainable and effective dental healthcare system. Implementing this model will significantly contribute to the overall enhancement of dental healthcare services throughout the Kingdom.

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