

Medical Colleges in Saudi Arabia: Can We Predict Graduate Numbers?

Alaa Althubaiti¹ & Mohammad Alkhazim²

¹ College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

² College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

Correspondence: Alaa Althubaiti, College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Mail Code: 3155, Riyadh, Saudi Arabia. Tel: 966-11-801-1111 Ex: 51035. E-mail: thubaitia@ksau-hs.edu.sa

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Abstract

The shortage of Physicians is a major problem in many countries. Medical colleges are often encouraged to increase the graduate numbers. In the Kingdom of Saudi Arabia, Saudi physicians form only 37.89% of the physician manpower. The remainder of the physicians are expatriates. It was recently estimated that the Kingdom would need 29,128 physicians by the year 2014 in order to maintain the same physicians-to-population ratio, i.e., 2.7 per 100,000. To solve the problem, the higher education institutions invested in medical education and increased their number of college graduates. However, there are many questions about whether this strategy will prove successful in covering the shortage or whether this will lead to problems, for example an excess in the number of physicians. These can only be answered if future graduate numbers are estimated and kept under control. In this study, common data mining techniques were reviewed and applied to the output of Saudi medical colleges over the past years. These techniques can be used to predict graduate numbers. The results show the importance of developing a national student information center to fix the data collection problems described in this paper.

Keywords: dropout, enrollment, graduation, higher education, medical college, prediction

1. Introduction

The healthcare systems around the world are built to distribute healthcare equally between health sectors. However, they face several challenges and problems. One of the major challenges lay in its manpower. In particular, the shortage of physicians or medical doctors is considered a crucial subject (Ricketts, Hart, & Pirani, 2000; Weiner, 2002; Staiger, Auerbach, & Buerhaus, 2009; Takata, Nagata, Nogawa, & Tanaka, 2011). Although careful planning was taken to insure the appropriate supply of health manpower (Hornby, Ray, Shipp, & Hall, 1980), this problem is manifested in the developing countries as part of the rapid growth in their economical and administrative systems.

For example, the health sector in the Kingdom of Saudi Arabia has increased from 3 hospitals that were present before the establishment of the Kingdom in 1932 to 86 hospitals in 2010. However, hospitals are highly dependent on non-Saudi manpower, which makes them vulnerable to difficulties in the recruitment and retention of expatriate physicians, especially during national and international crises. For instance, many international professionals left or were hesitant to work during the Gulf war in the Kingdom. Table 1 shows the number of Saudi manpower among others (Ministry of Health [MOH], 2010).

Table 1. National manpower at Saudi Healthcare System (MOH, 2010)

Sector	Physician	
	Saudi	Non-Saudi
MOH	1,441	5,412
Private	248	915
Other Governmental	6,010	6,294
Total (%)	7,699 (37.89%)	12,621 (62.11%)

Note. MOH-Ministry of Health.

Shortage of manpower is not a recent problem in the Kingdom and it has been present for more than a decade (Al-Omar & Chowdhury, 1999; Al-Ahmadi & Roland, 2005; Al-Shehri & Khoja, 2009). In order to solve this problem, a number of medical colleges have been established, which led to a steady increase in the number of medical graduates over the last ten years (since 2003). The worldwide graduation rates from medical colleges, such as in Canada and United Kingdom have also seen a sharp increase since 2000 (The Organization for Economic Co-operation and Development [OECD], 2011).

However, there are no published reports on the effectiveness of such a strategy in Saudi Arabia. In addition, graduation and enrollment rates are not under a periodic investigation to assess the impact of the increase in number of graduates.

In this study, we present a number of charts for historical information of graduates from Saudi medical colleges including the current status of development in medical education. We review the challenges facing old and newly established medical colleges. These challenges were approached using different techniques. We describe a number of methods that can be used to analyze the college graduates data and to predict an approximate value for the graduate numbers. The study will be of interest to readers and decision makers in higher education that are concerned with the problem of shortage in physicians and increasing number of medical graduates.

2. Method

The first step of this study was to describe historical trends of intake and outcome related to graduate numbers from colleges of medicine in Saudi Arabia. The data we used was obtained from the statistical department in the Saudi Ministry of Higher Education (MOHE, 2010). It represents the annual reports of the Ministry for the period between 1980 and 2009 (the last year of complete reported data). Data from private medical colleges were not included in this study, although these account for a total of three small colleges. All the medical colleges in the Kingdom offer a six-year program, followed by a one-year internship. A graduation rate was calculated by comparing the intake to medical colleges with the output of 6 years later (Parkhouse, 2001). Here, we calculated an approximate graduation rate based on the available records.

The second part of the study was to predict future graduate numbers of the medical colleges. Predicting graduation figures involves modeling and finding suitable input variables. Different statistical approaches have been used repeatedly (Joyce, Johannes, John, & Piterman, 2007; Staiger et al., 2009; Basha, Govardhan, Raju, & Sultana, 2010). Some of these approaches are easy to apply and available in most statistical software packages. For example, regression methods (Seber & Wild, 1989) for predictions are based on extrapolating the general graduation trend.

Our prediction used total historical graduation data for all medical colleges over seven years (2003-2009) to predict graduation figures for the years (2010-2020). To produce the best prediction model, this study applied the ordinary least squares (OLS) regression analysis. We assumed that the data has no dramatic jumps during the prediction years. The period 2003-2009 is used as a reference for the prediction since more consistent graduate numbers started reforming during this period. Therefore, less prediction errors can be expected.

To choose the most suitable prediction approach, a goodness of fit analysis was used to compare between regression methods. The equation estimation procedure was applied to attain the best fitting equation for the graduate numbers in 2003-2009. The linear, quadratic, growth and exponential regression equations were seen as suitable candidates. So a comparison between these equations was performed. For example, if a linear regression

equation is fitted, the total number of graduates is linearly regressed on the years using the model

$$y = b_0 + b_1x, \quad (1)$$

where y is the number of graduates for year x , b_0 and b_1 are the parameters or regression coefficients of the linear regression, b_0 is the constant (intercept) and b_1 is the slope of the regression line. If a nonlinear models is used, such as, the quadratic model given by

$$y = b_0 + b_1x + b_2x^2, \quad (2)$$

a quadratic term x^2 , interprets the nonlinear pattern in the observed data. Coded x values are often used to simplify the computational burden.

To complete the missing data points in the Ministry of Higher Education's reports, the mean imputation approach was applied. We use the software SPSS version 21.0 (SPSS IBM, New York, U.S.A) for the data analysis. All graphics work was created using the Software GraphPad Prism version 6.0c. P-value at significant level 0.05 was declared significant.

3. Results

3.1 Overview

In 2009, there were only eight universities that did graduate medical students. These universities were: King Saud University (KSU), King Abdulaziz University (KAU), King Faisal University (KFU), Um Alqura University, King Khaled University (KKU), Tibah University, Jazan, and Qassim University. Among these universities, a few started graduating medical students in the same year or shortly before.

The overall trend of total graduates from the medical colleges over the period 1980-2009 is presented in Figure 1. Although the number of graduates fluctuated considerably over this period, the overall trend reflects an increase in the graduate numbers. The trend shows an overall very steady increase in the period 1980-2000, and a rapid increase between 2000 and 2009. Most of the medical colleges increased their number of graduates over the last period. In addition, new medical colleges have started to graduate students.

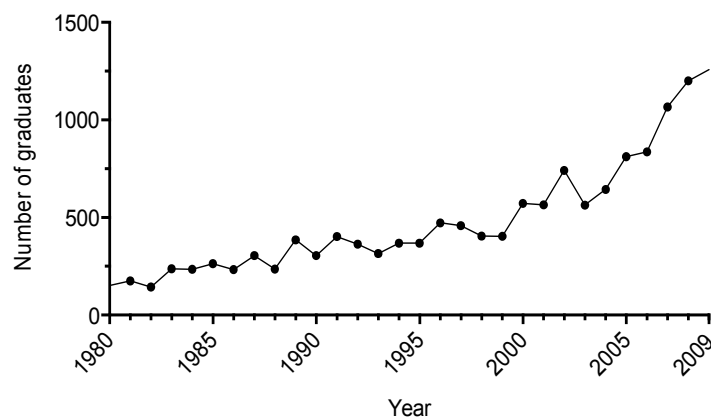


Figure 1. Number of total graduates from Saudi medical colleges, 1980-2009

Moreover, Figure 2 shows the number of male and female graduates from the medical colleges. In general, the number of female graduates is significantly lower than the number of male graduates. This can be justified by the fact that most of the medical colleges did not accept female students for a considerable period of time and there are still a few male-only medical colleges in the Kingdom.

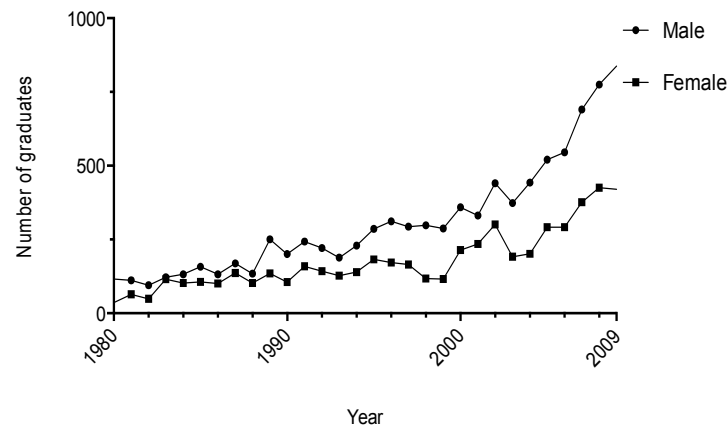


Figure 2. Number of total graduates from Saudi medical colleges by gender, 1980-2009

The overall increasing trend and development of medical colleges can also be represented using the average number of graduates in a period of time. For example, in 1980-1989, the oldest colleges, those that have been graduating students for over 25 years (i.e., KSU, KAU and KFU) were graduating on average 99, 89 and 51 medical students, respectively. In 1990-1999, the same universities were graduating on average 138, 121, and 86, respectively. In 2000-2009, average graduation numbers were 199, 184, and 152, respectively. These averages reflect the amount of growth in the Saudi medical colleges over three decades.

However, the growth in graduate numbers differs substantially between the medical colleges. Table 2 gives the percentage in change during the years 2000-2009. It is clear that some of the newly opened medical colleges experienced a fast growth in the number of graduates by having the largest change in percentage (as shown in Table 2).

Table 2. Saudi university medical college graduates: Percent change, 2000-2009

University	Total graduates		
	2000	2009	Per cent change
KSU	136	313	130.1%
KAU	201	312	55.2%
KFU	201	180	-10.4%
KKU	25	88	252%
Qassim	0	114	-
Jazan	0	53	-
Tibah	0	52	-
Um Alqura	10	141	1,310%
Total	573	1,200	109.4%

Note. KSU-King Saud University; KAU-King Abdulaziz University; KFU- King Faisal University; KKU-King Khaled University

During the period 1980-2009, the number of enrolled medical students reached 1,697 students. Figures 3 and 4 show the total number of enrolled students across the medical colleges and the total number of students by gender, respectively. As can be seen in Figures 3 and 4, the number of students enrolled fluctuates from year to

year and included some surprising drops or rises, such as, in 1997 when the enrollment numbers declined rapidly. Therefore, in contrast to the overall trend of graduate numbers, no noticeable increasing or decreasing trend can be observed from the enrollment data. One possible cause of this is the non-centralization of medical students enrollment, i.e., each university determines the appropriate number of students it can accept.

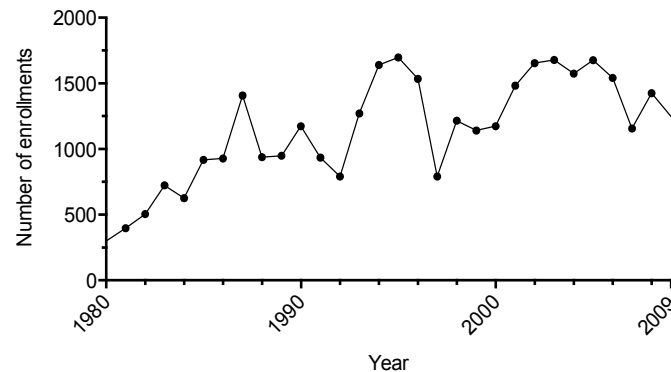


Figure 3. Number of total enrolled across Saudi medical colleges, 1980-2009

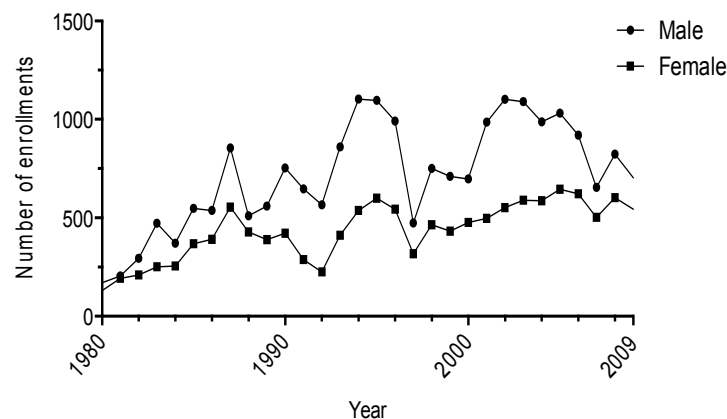


Figure 4. Number of total enrolled across Saudi medical colleges by gender, 1980-2009

3.2 Graduation Rate

We calculated the graduation rate for the years 1995-2004, since the enrollment is available for all the medical colleges within this time frame. A total of 13,246 students began medical studies and 8,260 doctors qualified in the years 2000-2009. Thus, 62% of the intake numbers in the years 1995-2004. The difference in the number of graduates from those enrolled six years earlier could be attributed to a few factors, such as dropouts and transfer movements. The dropout rate describes the rate or the percentage of college students that quit a study program without graduating or fail to complete it on time. The task of clarifying this gap is tedious since no clear records are available.

3.3 Prediction of Graduate Numbers

A comparison of goodness of fit tests showed that model (1) and (2) closely matches the observed data more than the other fitting equations. The coefficients for each regression equation and the F-test value from the goodness of fit tests are given in Table 3. The p-values are less than 0.05, so the models are an adequate fit for the data. Another way to see if the model is a good fit for the data is to examine the R^2 values. Models (1) and (2) have a large and equivalent R^2 values, i.e., 0.98. Here model (1) was used for further analysis since it was easier to apply. Therefore, an appropriate model for the data can be given by $y = 419 + 123.14 x$.

Table 3. Model summary and coefficient estimates for linear and quadratic models

Model	Model summary			Coefficient estimates		
	R ²	F	p-value	b ₀	b ₁	b ₂
Linear	0.98	205.49	1×10 ⁻³	419	123.14	-
Quadratic	0.98	83.82	1×10 ⁻³	437.29	110.95	1.52

The number of medical graduates is predicted to increase approximately to 2,636 graduates in 2020. The calculation of the predicted number of graduates in the years 2010-2020 is straightforward and illustrated in Table 4.

Table 4. Predicted Saudi medical college graduates, 2010-2020

Year	Predicted graduates
2010	1,404
2011	1,527
2012	1,650
2013	1,774
2014	1,897
2015	2,020
2016	2,143
2017	2,266
2018	2,389
2019	2,512
2020	2,636

Note that the predicted graduate number here is only a minimum for the actual one since newly opened colleges are expected to graduate more students in the forthcoming years. One disadvantage to the approach we used is that it does not account for the internal dynamics of enrollment from year to year and one grade to another.

4. Discussion

The study provides a general overview for the academic growth in the Saudi medical colleges during the period 1980 to 2009. The increase in graduation numbers implies task forces. One of the important tasks is the need for preparation of training programs after graduation, such as, residency or scholarship opportunities. Currently post-graduate medical training is limited in the Kingdom. Hence some difficulties may arise in training the medical graduates.

There is an essential requirement to learn more about the graduate numbers. Data mining techniques must be used in order to find scientific explanations for the data. No studies have been conducted to examine data mining issues in the Kingdom. However, these measures could come with computational burdens. One major obstacle is the need for accurate information on cohorts of graduates, i.e., follow up studies.

The implementation of valid and most reliable statistical techniques is encouraged. Appropriate statistical models should be used in projection of graduation rates, and any difference between the actual and projected rates is a proof not only for the contribution of the university to the educational outcome, but also for the accuracy of the model that is used to make the projection.

A more robust prediction can be made using enrollment, graduation and dropout rates. Complex predictions can

also be obtained by predicting graduation figures according to gender, ethnicity, geographical location, and nationality (Nelson-Jones & Fish, 1970; Lambert, Goldacre, Davidson, & Parkhouse, 2001). This cannot be done accurately using the present database. Currently, it is very difficult to obtain the required data in practice. Beside the fact that it requires long procedures, some of the data, such as drop out rates are perceived as a delicate matter.

In addition to the importance of predicting the number of graduates, information on enrollment data are also essential to examine. Such information will provide a solid background for innovative plans, decisions and developments in higher education. Enrollment of new students should be supervised in order to attain the 'right' supply of physicians. Newly established universities are advised to account for dropout or transfer rates when enrolling students.

The development of a national student information center would be an appropriate solution to fix the data collection problems described before. The responsibility of this centre would be to monitor and to keep clear records of students that enroll, graduate, transfer or dropout across all governmental and private medical colleges. It could also be responsible for proposing enrollment rates to the higher education institutions. By doing this, the centre will help in appropriate planning for future educational elements.

5. Future Recommendation

Our findings show that it is difficult under the current regulations to provide accurate prediction of future medical graduates and to obtain an answer for whether the current enrollment and graduation figures are in line with the need of the society. Thereby we recommend more visibility and accessibility to these numbers.

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