Predicting Future Health Demands in Jordan

Ghassan Al-Utaibi, Ph.D.[1]

ARTICLE INFO

Available online July 2013
Key Words:
health care
regression analysis
information system

ABSTRACT

This paper presents an information system for the health sector in Jordan. A structure for the information system is proposed using regression analysis. Projections for the year 2020 highlight the need for improved health care. Aspects related to improving health care and needed actions are addressed.

INTRODUCTION

Information systems are important tools in providing management, staff, researchers and academics with the needed information to support their activities and decision making (Haag, and Cummings 2010).

Health service information is vital in establishing a balance between demand and supply of medical personnel and establishments. In deciding to establish such a balance, there appears to be a need to rely on projected information. In this paper, a proposed information system for the health sector is given based on the notion of regression analysis.

The data collected and analyzed covers the period from 2004 to 2012. This data is divided into two sections. First, data related to medical personnel, which is recorded for the period from 2004 to 2012. Second, data related to health establishments, which is also recorded for the period from 2004 to 2012 (Department of Statistics, 2005-2012; Ministry of Health, 2012). The two sets of data are shown in (Tables 1 and 2) respectively.

A projection for the demand for physicians, dentists, pharmacists, nurses and midwives for the year 2020 is made (Tables 3). As for medical establishments, a projection for the demand for health centers, maternity and childhood centers, dental clinics, pharmacies, and beds, for the year 2020 is also made (Tables 4). It should be noted that the figures for dental clinics are for the government sector; no figures were available for private clinics. It is difficult to assess how this may affect this part of the study.

Table 1: Medical staff for the Period 2004-2012

Year	Physicians	Dentists	Pharmacists	Nurses	Midwives
2004	13987	3926	6735	9373	1582
2005	14858	4194	7100	10012	1654
2006	15983	4597	7554	10929	1839
2007	16963	4891	8087	12081	1955
2008	17799	5094	8409	13560	2051
2009	18526	5382	9274	15443	2180
2010	19635	5691	10890	17731	2312
2011	20530	6029	12163	19499	2379
2012	21884	6322	13487	21022	2532

[1] GPCube Inc., E-mail: ghassanmaster@yahoo.com

Table 2: Health Establishments for the Period 2004-2012

Year	Hospitals	Health Centers	Maternity Clinics	Dental Clinics	Pharmacies	Hospital Beds
2004	97	652	365	260	1616	9820
2005	98	663	385	274	1615	10141
2006	101	671	406	274	1657	11009
2007	103	679	416	285	1806	11029
2008	103	683	419	313	1883	11200
2009	104	684	431	319	1949	11351
2010	106	688	432	369	1963	11779
2011	106	692	435	377	1996	11991
2012	107	693	438	384	2185	12148

Table 3: Forecasting Statistics for Medical staff for the Period 2013-2020

Year	Physicians	Dentists	Pharmacists	Nurses	Midwives
2013	22585	6606	13471	22074	2649
2014	23543	6902	14305	23608	2768
2015	24501	7198	15140	25142	2887
2016	25459	7494	15974	26675	3007
2017	26417	7790	16808	28209	3126
2018	27375	8086	17643	29743	3245
2019	28332	8383	18477	31276	3364
2020	29290	8679	19311	32810	3483

Table 4: Forecasting Statistics for Health Establishments for the Period 2013-2020

Year	Hospitals	Health Centers	Maternity Clinics	Dental Clinics	Pharmacies	Hospital Beds
2013	109	703	457	403	2200	12557
2014	110	707	465	420	2270	12836
2015	112	712	473	437	2339	13114
2016	113	717	482	454	2409	13393
2017	114	722	490	472	2478	13672
2018	115	727	499	489	2548	13950
2019	117	732	507	506	2617	14229
2020	118	736	516	523	2687	14508

The satisfaction of the projected demand levels for the year 2020 will only keep Jordan at favourable levels in comparison with developing nations. However, Jordan must further improve upon those projected demand levels if it were to compare favourably with the developed nations. The study period, 2004-2012, was used as data after 2012 was not available at the time of preparing this study, and needed data for analysis purposes during this period was deemed acceptable.

REGRESSION ANALYSIS

The regression analysis was done by using the software package SPSS. A scatter diagram of the data shows the relationships between each of the medical staff and establishments with respect to time. All relationships show that a straight line equation is the best fit for such relations. Figure 1 shows the scatter diagram for the number of physicians and time. Table 5 gives the regression analysis treatment of such relationship. The linear equation is: $Y = 130006.86 + 957.85\ X$, where 130006.86 is the intercept of the straight line on the Y axis, and 957.85 is the slope of the straight line, which represents the amount of change of Y for each unit of X. The value .997 of 'r-squared', shows that the model could be relied upon in over 99% of cases to predict the number of physicians for a certain year. The higher the value of 'r-squared', the better the fit of the model. The regression analyses for all relationships show that values of "r-squared" for all relationships are above 0.90. The regression analysis treatment was used for each of the medical staff and establishments mentioned above.

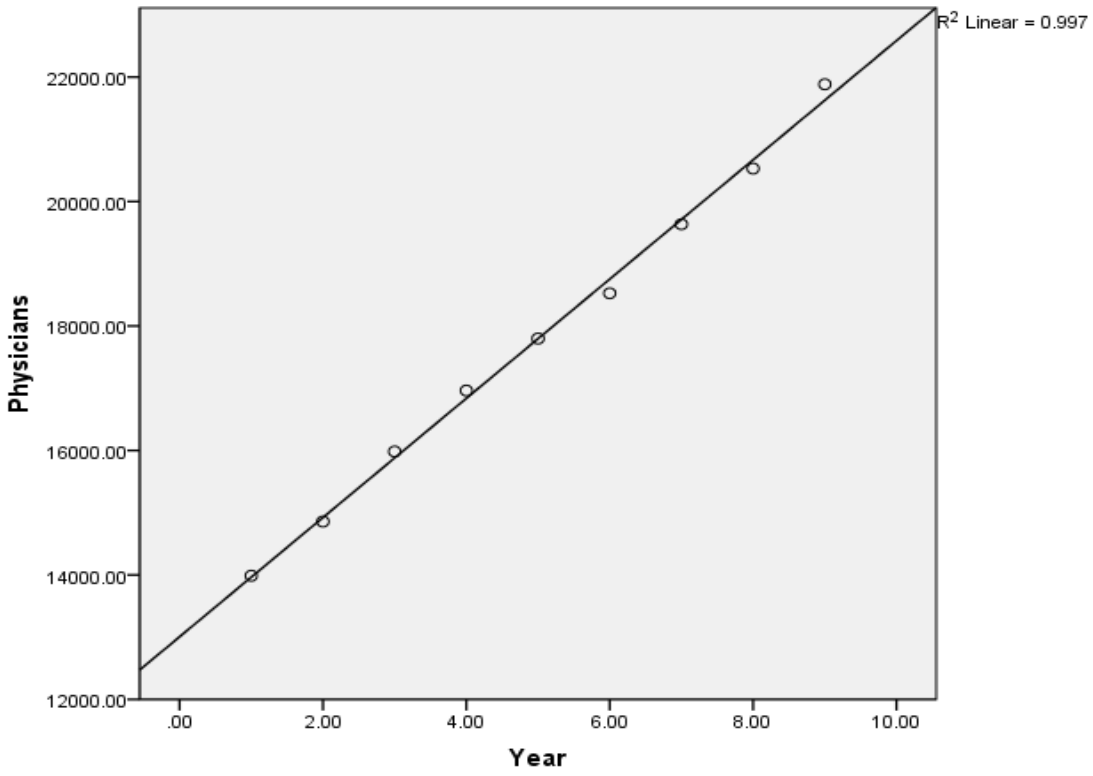

Fig. 1: Number of Physicians for the Period 2004-2012

MEDICAL STAFF

Medical staff figures analyzed are for physicians, dentists, pharmacists, nurses and midwives. The figures for nurses include both male and female nurses, as no separate figures are available.

The figures given indicate an increase in the numbers of all types of medical staff. Regression analysis shows that all relationships against time are positive and linear.

The number of physicians increased from 13987 in 2004 to 21884 in 2012; an increase of 56.5% over the 9-year period. The relationship for physicians is expressed as follows:

$$Y = 13006.86 + 957.85\ X$$

This treatment is applied to all following relationships.

The number of dentists has increased by 61% over the same 9-year period. This is represented as follows:

$$Y = 3644.444 + 296.1333\ X$$

The number of pharmacists has increased by 6752 from 6735 in 2004 to 13487 in 2012; an increase of 100.3%. The fitted line for the number of pharmacists is given by:

$$Y = 5128.556 + 834.2667\ X$$

For nurses, the increase in numbers between 2004 and 2012 was 124%. The relationship for nurses with respect to time is shown by the following straight line:

$$Y = 6736.972 + 1533.717\ X$$

The number of midwives has increased by 950, which represents a 60% increase over the same 9-year period. The straight line equation for midwives is expressed as:

$$Y = 1458.278 + 119.1\ X$$

Table 5: Regression Analysis for Physicians for the Period 2004-2012

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Physicians	9	13987.00	21884.00	17796.1111	2627.32071
Valid N (listwise)	9				

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998[a]	.997	.996	157.62321

a. Predictors: (Constant), Year

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.505E7	1	5.505E7	2215.674	.000[a]
	Residual	173915.539	7	24845.077		
	Total	5.522E7	8			

a. Predictors: (Constant), Year
b. Dependent Variable: Physicians

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13006.861	114.511		113.587	.000
	Year	957.850	20.349	.998	47.071	.000

a. Dependent Variable: Physicians

Casewise Diagnosticsa

Case Number		Std. Residual	Physicians	Predicted Value	Residual
dimension0	1	.141	13987.00	13964.7111	22.28889
	2	-.410-	14858.00	14922.5611	-64.56111-
	3	.651	15983.00	15880.4111	102.58889
	4	.791	16963.00	16838.2611	124.73889
	5	.018	17799.00	17796.1111	2.88889
	6	-1.446-	18526.00	18753.9611	-227.96111-
	7	-.487-	19635.00	19711.8111	-76.81111-
	8	-.886-	20530.00	20669.6611	-139.66111-
	9	1.627	21884.00	21627.5111	256.48889

a. Dependent Variable: Physicians

MEDICAL ESTABLISHMENTS

As can be seen from (Table 2), the number of health establishments in Jordan has increased over the period from 2004 to 2012. The table shows an increase of 6% in the number of health clinics. The fitted curve of health centers is expressed by the following straight line equation:

$$Y = 654.1667 + 4.833333\ X$$

As for the maternity and childhood centers, the percentage increase over the 9-year period is 20. The maternity and childhood Centers relationship is given as:

$$Y = 371.6944 + 8.483333\ X$$

As mentioned before, the figures for dental clinics are those for government clinics only. The number of those dental clinics has increased by 48% over the period from 2004 to 2012. The straight line equation for dental clinics relation is shown as:

$$Y = 231.4722 + 17.15\ X$$

The number of pharmacies has increased by 35% over the same period. The pharmacies regression equation is:

$$Y = 1504.389 + 69.56667\ X$$

The number of available beds is an important health indicator. This number increased by 24% over the period from 2004 to 2012. The relevant equation is:

$$Y = 9769.444 + 278.7333\ X$$

HEALTH SERVICE DEMAND IN THE YEAR 2020

In order to establish health service demands for the year 2020, the population of Jordan for that year has to be estimated. The following equation is used to calculate Jordan's population in the year 2020:

$$\mathbf{P}2020 = \mathbf{P}2012\ (1 + \mathbf{G})^{8}$$

Where:

$\mathbf{P}2020$ = estimated population in the year 2020.

$\mathbf{P}2012$ = population in the year 2012.

With population growth rate is represented by G.

The annual rate of growth of the Jordanian population in 2012 was 2.2% (Department of Statistics, 2012; WHO, 2011). It is assumed that this growth rate will remain constant during the period 2012-2020. Using the above equation yields an estimated population of 7,469,475 for Jordan in the year 2020.

Two major health indicators which are used worldwide to analyze future health demands are population per physician and population per bed. By using the projected figures for physicians and beds for the year 2020 shown in (Tables 3 and 4), we can calculate the figures for population per physician and population per bed for the year 2020. Population per physician and population per bed for Jordan for years 2004, 2009, 2011 and 2020 are given in Table 6.

Table 6: Population per physician and population per bed for Jordan years 2004, 2009, 2011 and 2020

Year	Pop / Phys	Pop / Bed
2004	588	554
2009	291	527
2011	288	521
2020	341	515

The figures in the table indicate an improved population per physician ratio. However, the trend for population per bed is negative, indicating the need for a much higher number of beds in order to maintain future demand increases.

As can be seen from (Table 3), the demand for physicians in the year 2020 is 29290. As the figure for 2012 is 21884, a new demand of 7406 physicians is needed over an 8 year period. This averages 926 per year. If it is assumed that a constant turnover rate of 10% is applied to both new recruits and the original population of physicians, then during 2013, the average annual turnover will be 2351. Therefore, demand in 2013 becomes $926 + 2351 = 3277$ physicians. In order to satisfy this new demand, a need arises to recruit physicians both locally and from abroad.

Graduates from medical schools in Jordan for 2012 total 875 (Ministry of Higher Education and Scientific Research 2011-2012). This figure includes both Jordanian and non-Jordanian students. As for Jordanian medical students studying abroad, their number totaled 115 for the year 2010-2011 Ministry of Higher Education and Scientific Research 2011-2012). This will give an average of 19 graduates per year assuming a six-year period for earning the first university degree. If it is assumed that all graduates (local and from abroad) are recruited to work in Jordan, this will give a total number of 894 physicians every year. This is well below the projected yearly demand of 3277.

LEVEL OF HEALTH SERVICE

In order to establish the level of health service in Jordan in comparison to other countries, two major indicators are used. Those indicators are population per physician and population per bed. Table 7 shows population per physician and population per bed for some selected countries including Jordan (World Health Organization, 2011)

Table 7: Population per physician and population per bed for some selected countries

Country	Pop / Phys (year)	Pop / Bed (year)
Bahrain	694 (2011)	526 (2011)
Canada	524 (2011)	294 (2011)
Egypt	353 (2011)	588 (2011)
France	286 (2011)	141 (2011)
India	1667(2011)	1111 (2011)
Japan	485 (2011)	73 (2011)
Jordan	291 (2011)	521 (2011)
Morocco	1613 (2011)	909 (2011)
Qatar	362 (2011)	714 (2011)
Saudi Arabia	1064 (2011)	455 (2011)
Switzerland	246 (2011)	189 (2011)
Syria	667 (2011)	667 (2011)
UAE	508 (2011)	526 (2011)
UK	365 (2011)	294 (2011)
USA	375 (2011)	323 (2011)
Yemen	3333 (2011)	1420 (2011)

CONCLUSIONS AND RECOMMENDATIONS

An information system for the health sector based on the notion of regression analysis is proposed. The aim of the system is to provide decision maker with the needed forecast information to help them plan for a better health service. The main findings of this study indicate that the level of health service in Jordan compares favourably with developing countries, but lags behind in comparison to developed countries. Also, it is seen from the regression analysis of data that a simple linear regression model is the best fit for all types of medical staff and health establishments. However, in order to raise the level of health service to the levels enjoyed by developed countries, much has to be done in terms of increasing the numbers of physicians and other medical staff as well as increasing the number of beds. Although the new demand for physicians can partly be met by recruiting local medical graduates in addition to the Jordanian medical graduates from abroad, this is not sufficient to meet the overall demand. It is recommended here that more places are made available at existing medical schools and more schools are opened at universities that do not have medical schools. To bring Jordan in line with developed nations, it is recommended that more investment is made to increase the number of beds in existing hospitals and increase the number of hospitals. This increase should be far higher than the projected figure given for the year 2020.

REFERENCES

Ball, Marion J. and Judith V. Douglas (Eds.), 2012 Performance Improvements through Information Management: Health Care's Bridge to Success (Health Informatics). Springer N.Y.

Department of Statistics 2012. Statistical Yearbooks 2004-2012, Jordan

Haag, Stephen, and Maeve Cummings 2012. Management Information Systems for the Information Age, 9th Ed. McGrow and Hill Higher Education

Jordan Professional Associations, Health Statistics 2004- 2012 Jordan Professional Associations, Amman, Jordan

Ministry of Health 2012. Statistics and Health Indicators 2004 -2011. Jordan

Ministry of Higher Education and Scientific Research, Yearly Statistics, 2011-2012, Jordan

SPSS. 2010. SPSS Release 18.0, Chicago, IL.

World Health Organization 2011. World Health Statistics 2004 – 2011. World Health Organization, Geneva.