Adjustment factors to per capita health-care indicators in countries with expatriate male-majority populations

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عوامل لتصحيح مؤشرات الرعاية الصحية للفرد في البلدان التي أغلبية سكانها من الذكور المغتربين

التجاني حسين

الخلاصة: شهد عدد السكان في بلدان مجلس التعاون الخليجي من عام 2000 إلى عام 2010 زيادة قدرها 53٪، مقارنة بمتوسط الزيادة العالمية والتي بلغت 13٪. وقد تفاوتت المعدلات بين البلدان؛ حيث تراوحت بين 23٪ في عُمان إلى 198٪ في قطر. وكانت القوة الدافعة الرئيسة لهذه الزيادة الحادة في عدد السكان هو ارتفاع الطلب على العمالة الوافدة. ولذا، فإن الهدف من هذه الدراسة هو تصحيح تعداد السكان في بلدان مجلس التعاون الخليجي بغية التأكد من أن المقارنات مع مؤشرات الأداء الرئيسة للرعاية الصحية في بلدان أخرى تعبِّر عن التركيبة السكانية. وخلصت الدراسة إلى أن تصحيح تعداد السكان في دول مجلس التعاون الخليجي له دور أساسي في تحديد الإنفاق على الصحة والنواتج الصحية، وأن التنبؤات غير الدقيقة من شأنها أن تؤدي إلى مبالغة خطيرة في حاجة بلدان مجلس التعاون الخليجي إلى الاستثمار في قطاع الرعاية الصحية. ويمكن لواضعي السياسات أن يستفيدوا من النماذج السكانية الواردة في هذه الدراسة من أجل وضع خطط دقيقة لتقديم الرعاية الصحية.

ABSTRACT From 2000 to 2010, the population in the Gulf Cooperation Council (GCC) countries underwent an increase of 53%, compared with an average global increase of 13%. The rates varied by country, ranging from 23% in Oman to 198% in Qatar. The main driving force for this sharp increase in population was the high demand for immigrant labour. The aim of this study was to adjust the population in the GCC countries in order to ensure that the comparisons of health-care key performance indicators with other countries account for the composition of the populations. The conclusion of the study was that adjusting the population in the GCC is instrumental for determining health spending and health outcomes, and that inaccurate forecasting would result in serious overestimation of the need for GCC countries to invest in the health-care sector. Policy-makers can utilize the population models in this study to accurately plan for health-care delivery.

Facteurs d'ajustement aux indicateurs de soins de santé par habitant dans des pays où les populations d'expatriés sont majoritairement de sexe masculin

RÉSUMÉ De 2000 à 2010, la population des pays du Conseil de coopération du Golfe a augmenté de 53 %, par rapport à une augmentation moyenne mondiale de 13 %. Les pourcentages varient d'un pays à l'autre, allant de 23 % à Oman à 198 % au Qatar. L'importante demande en main-d'œuvre immigrante constituait l'élément moteur principal de cette forte augmentation de la population. La présente étude visait à ajuster les populations dans les pays du Conseil de coopération du Golfe afin de garantir que les comparaisons des indicateurs de performance clés pour les soins de santé avec d'autres pays tiennent compte de la composition des populations. L'étude concluait dans un premier temps que l'ajustement des populations des pays du Conseil de coopération du Golfe était essentiel pour déterminer les dépenses de santé et les résultats sanitaires, et dans un deuxième temps que des prévisions inexactes entraîneraient d'importantes surestimations de la nécessité pour les pays du Conseil de coopération du Golfe d'investir dans le secteur des soins de santé. Les responsables politiques peuvent utiliser les modèles de population de cette étude pour planifier avec exactitude la prestation de soins de santé.

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Introduction

Benchmarking the populations of countries in order to compare health spending and outcomes between nations and regions is a logistical task of considerable complexity. In projections of health spending, estimates are usually based on the projected effects of demographic factors with regard to supply and demand for health-care services (1). In the period between 2000 and 2010, the population of the 6 Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)—increased dramatically (2). A financial boom driven by high oil and gas revenues has been used to build and expand the infrastructures in these countries and enlarge the window for immigrant workers to join the national labour force. Non-nationals have come from developed and other Arab countries to work mainly in the government, oil and gas sectors, while single, male workers have come mostly from the Indian sub-continent to work in blue-collar jobs such as construction. Table 1 shows the pattern of population increase by sex for the GCC countries during the period 2000–10, and compares it with the global population. The global population increased by 13%, while the ratio of males to females remained the same at 102:100. However, the population in these in GCC countries grew by 53%, significantly higher than global growth rates, and the male to female sex ratios also increased dramatically over the same period. The higher ratio of males to females was evident in 2000, and continued to increase through to 2010. Figure 1 illustrates these distinct characteristics of the GCC population: the sex imbalance in the working-age groups, which causes the pyramid to be asymmetric, and a bulge in the working-age groups caused by the high number of immigrants who are residing in these countries temporarily in order to meet the demands of the job market. This bulge should not be interpreted as a classic youth bulge, which would indicate a contracting population.

This demographic bias, dominated by the working-age male, must be taken into account in any attempt to benchmark per capita health-care key performance indicators (KPIs) against countries which have a more balanced population distribution. If, for example, the number of mammograms conducted is measured per million of raw population, then for the GCC countries the measurement could indicate that the health system discriminates against women (since the numbers would be lower than the OECD norms purely due to the sex imbalance in society). To adjust for this, the raw population figures must be modelled to reflect the different sex distribution within the GCC.

The supply of new hospitals in the GCC countries is on the rise, and this rise is primarily sponsored by the government (3,4). Similar efforts are also underway for the recruitment of health-care personnel. Roberfroid et al. offered a presentation of the typology of existing forecasting approaches for anticipating physician supply (5). These approaches are the supply projection, the demand-based approach and the needs-based approach. A fourth approach is benchmarking health systems with populations that have similar health profiles. All of these approaches rely on accurate measures of population size. In order to draw valuable conclusions from a reference country or region, Roberfroid et al. argued that adjustments are necessary for the population's demographics (5).

This paper discusses how to benchmark the population of the GCC countries in order to make international comparisons of health spending and health outcomes. The process of devising and then comparing KPIs has been a focus of research since the 1990s (6,7). As elsewhere, the health debate has centred on how to use selected KPIs to improve health-care delivery performance (8). The primary purpose of this paper was to adjust the population in the GCC countries in order to ensure that the comparisons of health KPIs take account of the composition of different populations.

Table 1 Pattern of total population growth in Gulf Cooperation Council countries, 2000–2010

| Country	Year 2000		Year 2010		Population growth 2000–2010
	Population	Male to female ratio	Population	Male to female ratio	
Bahrain	638 193	133:100	1 261 835	163:100	98
Kuwait	1 940 786	144:100	2 736 732	150:100	41
Oman	2 264 163	127:100	2 782 435	144:100	23
Qatar	590 957	186:100	1 758 793	317:100	198
Saudi Arabia	20 045 276	117:100	7 448 086	122:100	37
United Arab Emirates	3 033 491	203:100	7 511 690	233:100	148
World (× 1000)	6 118 131	102:100	6 894 378	102:100	13

Source: World DataBank (2).
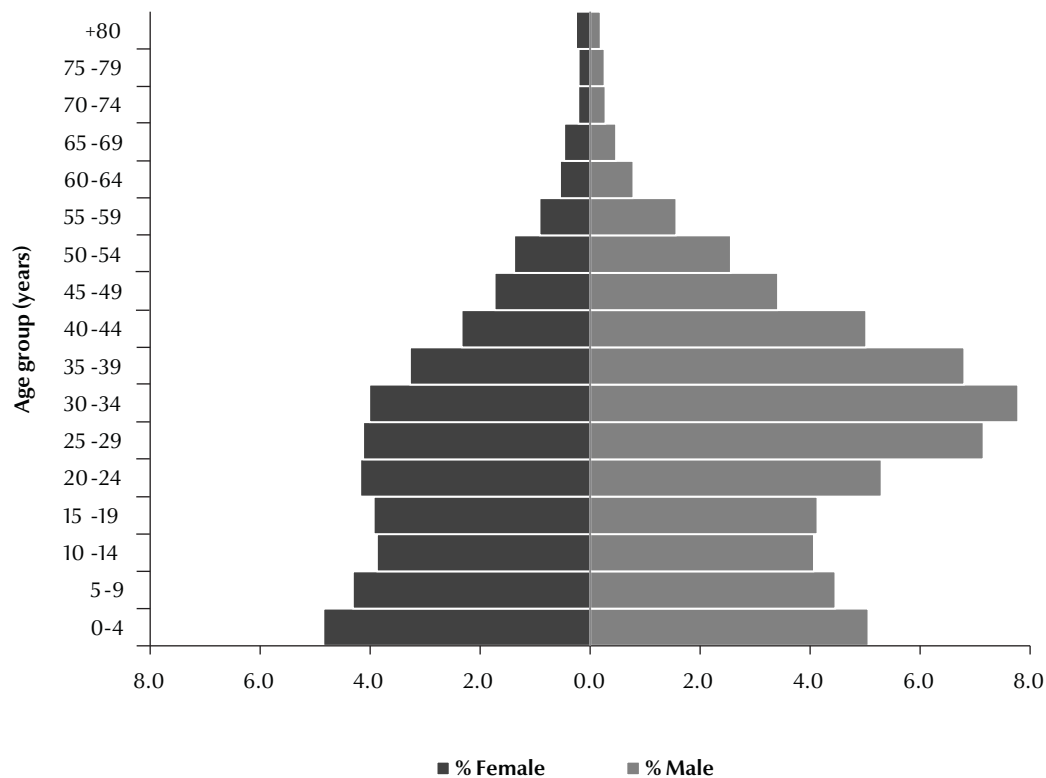
Figure 1 Population pyramid for Gulf Cooperation Council (GCC) countries, 2010: source: World DataBank (2)

Methods

The source for the data used in this study was the World Bank's *World DataBank* (beta) (*2*). The data were reported by age group, year, sex and country. We downloaded data for the period 1980 to 2011. While the GCC countries produce their own periodic population data through national statistics offices, we used the World *DataBank* for completeness and consistency.

The population data to input to the model was drawn from 5 regions: Middle East, Northern Africa, Eastern Europe, Asia (excluding Middle East), Latin America and the Caribbean. These regions were selected for 2 reasons. First, these countries are the primary native countries of the expatriate population in the GCC region, and thus can be expected to demonstrate a sex ratio that correlates to the modelled population. Secondly, these countries are less developed, with lower dependence ratios, and can be expected to have

a population pyramid that is close to the modelled GCC population. In contrast, we excluded the data from high-income countries because these countries have different dependency ratio and population demographics than in the GCC.

A regression model based on a prediction procedure was used to produce a modelled male population aged 20–60 years. The main outcome measures were each GCC country's male population for the age groups 20–59 years, measured in 5-year age intervals (a total of 9 age groups). Each country's male population was replaced by a missing value for the years 2000 and beyond. The regression models were then used to predict the "missing" age groups of males for each country.

The decision to adjust only the male population in these countries represented a conservative approach. The female population was not modelled for 2 reasons. First, the proportion of female single workers is very low. Data from Qatar Statistics Authority for example

showed that in 2010 males occupied 90% of the blue-collar jobs (*9*). Secondly, health-care utilization among single females, and females of all ages, is relatively higher than for single males and has been consistently documented in a number of studies (*10–15*).

The primary independent variables included the age groups, and the female population of each country. Thus, the population groups from a total of 106 countries, selected by sex, and for the period 1980–2011 was used to predict the modelled population for the 9 male age groups in the 6 GCC countries. To adjust for variations among countries, we included country fixed effects, i.e. a dummy for each country. In addition, the year (continuous variable) was used to control for the world population trend.

Both sides of the regression model were transformed to logarithm values, to account for the exponential relationship between the dependent variable and the predictors. The coefficients of the log-transformed variables measured

the elasticity of each of the predictors to the dependent variable. Thus, the model used in this study was a linear regression of log-transformed variables, and can be illustrated in equation 1: log (male population) = $\beta0 + \beta1$ log (female population) + $\beta2$ log (age group) + $\beta3$ log(year) + country fixed effect + error term.

The unit of observation was the age group, and at each year of the data. To account for the bias in the predictions of the transformed variables, the predicted values were multiplied by the exponential of the mean square of the error term (16).

Once the predicted value of the total population was estimated, an adjustment factor (Ω) was then computed. The adjustment factor for each country was the rate of the total modelled population to the total actual population, as in equation 2: Adjustment factor (Ω) = (modelled population)/(actual population).

For example, an adjustment factor of 0.80 indicates that the estimated total population is 80% of the actual population. The per capita health-care indicators were adjusted by dividing the nominal KPI by Ω. For example, a nominal per capita KPI of 100 and Ω of 0.80 produced an adjusted KPI of 125. The statistical software *Stata* was used to conduct the analyses.

Sensitivity analyses

We used other models in our sensitivity analysis. First, we used age in its linear untransformed format. This model was used as our "lower estimates" model, because the results showed a greater degree of adjustment in the population. Secondly, we used other specifications for the age variable. These specifications included age and age squared, age fixed effect and the inverse of age. Thirdly, we used alternative specifications for the year trend variable. These specifications were the linear untransformed, and the year fixed effects. Fourthly, we interacted age and year, using the different specifications of these variables.

We used *Fitstat* and *Linktest* to test the accuracy of fit for each of these models, and compared the results with our log-transformed model. All of the above alternative models showed inferior accuracy of fit when compared with the log-transformed and "lower estimates" models. Regardless of the model's specifications, the predicted male population from these alternative models were within the boundaries of the 2 reported models in this paper.

Results

The modelled male population in the GCC countries was estimated as being much lower than the actual proportion. The results are shown in Table 2. The higher the actual male to female ratio, the lower the adjustment factor (Ω) was. For example, the actual population in Qatar was 1.759 million, and the sex ratio was 317:100 for 2010. The results show that the adjustment factors for the lower and higher estimates ranged between 0.61 and 0.66 respectively and the adjusted sex ratios ranged between 151:100 and 170:100 respectively.

In contrast, Table 2 shows that the actual population in Saudi Arabia was 27.45 million and the sex ratio was 122:100 in 2010. Although Saudi Arabia had a higher population than any other GCC country, the adjustment factors were the highest, i.e. 0.96 and 0.97 for the lower and higher estimates respectively, and the adjusted sex ratios were 114:100 and 118:100 for the lower and higher estimates respectively.

Population pyramids for the GCC countries in Figure 2 show the actual and modelled male population of the higher estimates. The bulge was still present for males in the working age groups, due to the high male population in these countries, even with the adjustment. However, the pyramids tended to be more symmetrical. Countries with higher actual male to female ratios, such as Qatar and the UAE, showed a higher reduction in the modelled male population. However, the imbalance still existed. Countries with lower actual male to female ratios, such as Oman and Saudi Arabia, had relatively lower

Table 2 Actual and modelled population in Gulf Cooperation Council countries, 2010

Country	Actual population		Modelled population			
			Adjustment factor (Ω)		Male to female ratio	
	(× 1000)	Male to female ratio	Lower estimate	Higher estimate	Lower estimate	Higher estimate
Bahrain	1 262	163:100	0.81	0.84	115:100	123:100
Kuwait	736	150:100	0.91	0.94	127:100	132:100
Oman	2 783	144:100	0.87	0.88	110:100	112:100
Qatar	1 759	317:100	0.61	0.66	151:100	170:100
Saudi Arabia	27 448	122:100	0.96	0.97	114:100	118:100
United Arab Emirates	7 512	233:100	0.73	0.79	139:100	159:100

The lower estimates used age instead of log (age) as in equation 1 in the Methods. Higher estimates used equation 1. The adjustment factor (Ω) was computed by dividing the total estimated population by the actual total population.
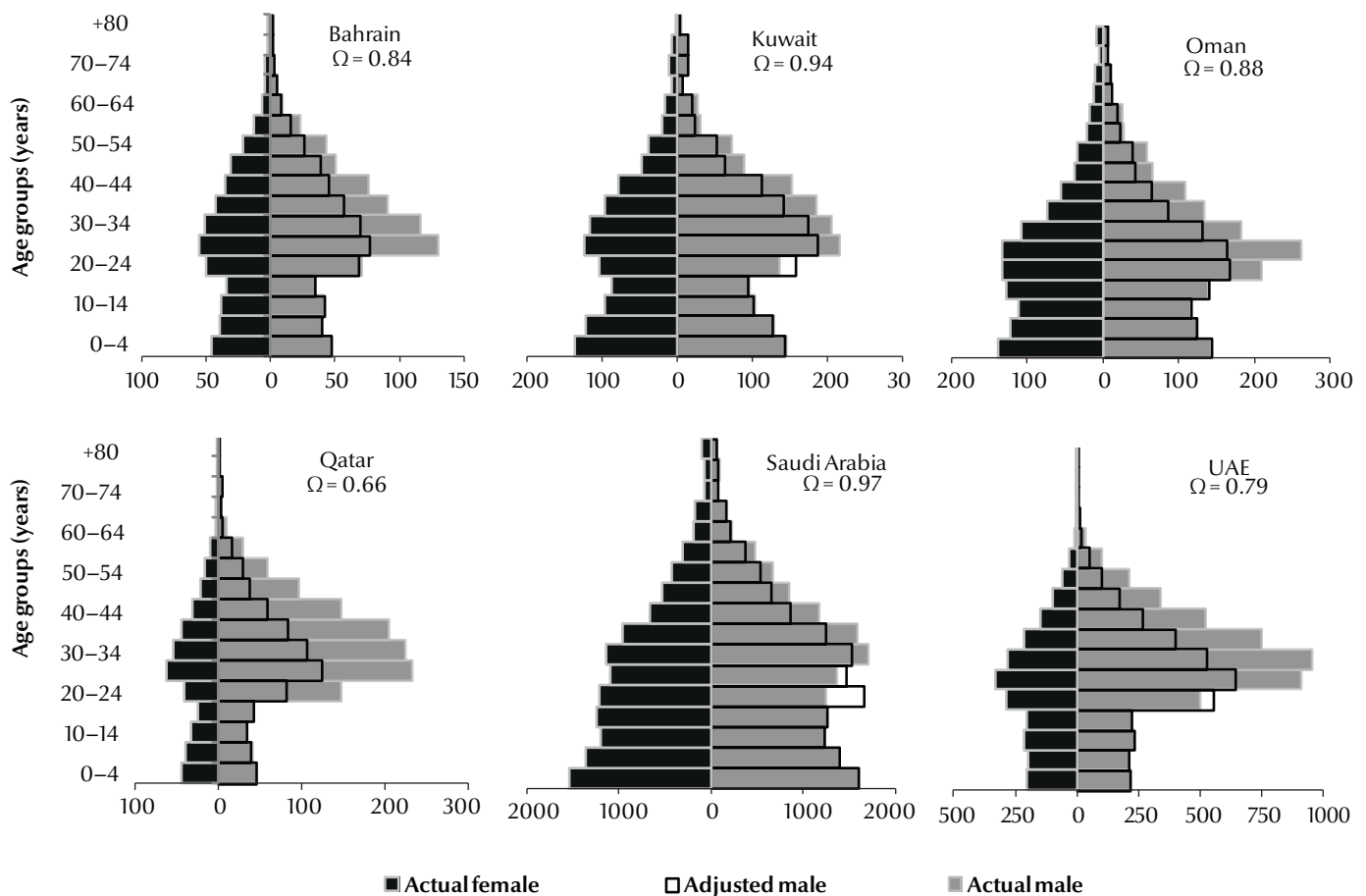
Figure 2 Population pyramids for the Gulf Cooperation Council countries, actual and modelled (higher estimates), 2010. The adjustment factor (Ω) was computed by dividing the total estimated population by the actual total population (UAE = United Arab Emirates)

reductions in the modelled male population.

Table 3 compares the most common per capita KPIs in the health-care sector in GCC countries, using the actual populations, and the adjustment factors. These indicators are per capita total health expenditure and number of hospital beds per 10 000 and number of physicians per 10 000. Table 3 also shows the same indicators for the countries in the Organization of Economic Cooperation and Development (OECD) as a reference group (*17,18*). Using the actual population, the hospital beds per 10 000 were lower in the GCC than those in OECD, ranging from 12.3 in Qatar to 22.0 in Saudi Arabia. Using the adjustment factors, these countries had higher indicators. With the higher

adjustment, the indicators ranged from 18.7 in Qatar to 24.4 in UAE.

Discussion

Deriving good comparisons of international health care is a complex task, which combines a need to capture information on both inputs (expenditure) and outcomes and to adjust both these measures to reflect variations in the underlying population. In this case the study has focussed on how to adjust skewed population figures, especially for those health KPIs that use per capita measures.

The results of this study show that in the absence of the adjustment factors, the actual indicators can mislead policy-makers, possibly resulting in an

undersupply of health-care resources input. For example, the hospital beds per 10 000 indicator underestimated 1086 hospital beds in Qatar (actual: 12.3; adjusted: 18.7) and 2552 hospital beds in Saudi Arabia (actual: 22.0; adjusted: 22.6), using the lower adjustments.

The difference in beds (underestimates) was computed by dividing the actual KPI by the adjustment factor, and then subtracting the product from the actual capacity. For instance, according to World Health Organization (WHO) data in 2012 (*18*) Saudi Arabia had a total of 59 810 hospital beds in 2010, and the adjustment factor was 0.97. Thus the product was 61 660 (59 810/0.97) and the difference was 2552 (61 660–59 810).

Table 3 Per capita health-care key performance indicators in Gulf Cooperation Council countries using actual and modelled populations, 2010

Country	Population (× 1000)			Hospital beds (per 10 000)			Physicians (per 10 000)			Total per capita health expenditure (US$)		
		Adjustment factor (Ω)[a]			Adjusted			Adjusted			Adjusted	
	Actual	Lower estimate	Higher estimate	Actual	Lower estimate	Higher estimate	Actual	Lower estimate	Higher estimate	Actual	Lower estimate	Higher estimate
Bahrain	1 262	0.81	0.84	17.7	21.1	21.9	21.1	25.1	26.1	1 108	1 320	1 373
Kuwait	2 736	0.91	0.94	20.0	21.4	21.9	21.0	22.4	23.0	1 416	1 513	1 549
Oman	2 783	0.87	0.88	17.7	20.2	20.4	17.5	19.9	20.1	497	566	572
Qatar	1 759	0.61	0.66	12.3	18.7	20.1	26.9	40.9	44.0	1 715	2 611	2 806
Saudi Arabia	27 448	0.96	0.97	22.0	22.6	23.0	21.8	22.4	22.8	714	733	747
UAE	7 512	0.73	0.79	19.3	24.4	26.5	27.9	35.3	38.4	1 520	1 926	2 090
OECD average[b]	1 232 402	–	–	33.7	–	–	31.4	–	–	3 265	–	–

[a]The adjustment factor (Ω) was computed by dividing the total estimated population by the actual total population.
[b]Sources: (17,18).
UAE = United Arab Emirates; OECD = Organization of Economic Cooperation and Development;.

Using this same computational method to measure the difference in actual versus adjusted beds, the number of physicians per 10 000 shows that Qatar and the UAE had higher values than the OECD average, even when using the higher population estimates. For example, using the higher adjustment factors, the results can be translated into an equivalent of an extra 2438 physicians per 10 000 in Qatar (actual: 26.9; adjusted 44.0) and an extra 5572 physicians per 10 000 in the UAE (actual 27.9; adjusted: 38.4). The other GCC countries also showed similar patterns, but to a lesser extent. For example, these computational methods show an equivalent of an extra 507 physicians per 10 000 in Bahrain and an extra 366 physicians in Kuwait.

The classic indicator—total per capita health expenditure—showed wide variations across GCC countries, using either actual or modelled populations. Oman was estimated to spend an actual US$ 497 per capita in 2010, while Qatar spent US$ 1715 per capita. Using the (lowest estimate) adjustment factors, this measure was still low in Oman (US$ 566 per capita) compared with Qatar (US$ 2611 per capita).

Several studies have used corrected population approaches to measure population-based indicators. The current study also argues that adjustments are necessary for population demographics in order to draw valuable conclusions from a reference country or region. In particular, the adjustments should be made for the GCC countries, where the sex imbalance is pronounced.

For instance, in a per capita data study that focused on the size of an ageing population, Scheffler et al. used 2 models to formulate workforce policy and determine where physician shortages were likely to occur by 2015 (19). The estimates were based on data from the WHO and the World Bank. The study utilized 2 modelling approaches for calculating the future global requirement for physicians in WHO regions. The first was a needs-based model, and the second was based on the projected rate of economic growth for each country.

In a different study, variables that were controllable by health planners were selected as parameters to simulate different scenarios in the calculation of supply and of deficit or surplus. Population data for the demographic growth and ageing of populations was

included, due to the projected increasing need for specialized care (20). The demand/need submodel was based on the hypothetical growth rate in the number of health specialists to 1000 population, using data provided by the United States Department of Health and Human Services (20).

Birch et al. developed an extended analytical framework that incorporated population health needs, the level of service required to respond to health needs and provider productivity as variables in determining future requirements for health-care services (1). They identified separate determinants for provider requirements. Population size represented the strongest demographic determinant in their study (1).

Kane et al. confirmed the influence of an ageing American population in calculating health-care spending according to population size (21). Although the absolute number of physicians in the United States was expected to increase by 24% between 2000 and 2020, general population growth was expected to exceed the rate of growth in the number of physicians. Failure to accurately measure the population could result in misleading policy decisions. In a review of studies of the correlation

between physician density (physician to population ratio) and health care consumption, Leonard et al. confirmed that more physicians may induce more consumption, i.e. "a bed built was a bed filled" (p. 121) (22). This supplier-induced demand was described as physician-driven, representing competitive activity among health professionals to encourage health-care use in order to gain remuneration through services (22). This GCC study argues that in the absence of population adjustment measures, it could result in an oversupply of health-care resources, which might lead to changes in behaviours such as supplier-induced demand or an underproductive health workforce.

Huang et al. constructed a spending projection model for diabetes, in order to inform health-care budget decisions in the United States (23). Within the United States, health-care costs are rising, due to significant pressure from demographic forces such as a growing elderly population (23). The population size of people with diabetes was used as a base for projections, with the expectation that more individuals would become diabetic as they aged.

The studies reviewed consistently indicate that no best practice exists for benchmarking the populations of countries for the purpose of projecting health spending and outcomes. These studies do indicate that the value of measurement lies in identifying current and emerging population trends in order to respond with accuracy (5).

The technical focus in this paper remains how to adjust the population structure in the GCC countries (24). For example, it is generally acknowledged that older people have greater health-care needs than younger people, even if, more accurately, these costs are actually concentrated in the final year of an individual's life (25). However, just controlling for age may not be enough (26,27). The likely health demands of a given population in the age range of, for example, 60–70 years will vary due to reasons such as national differences in diet, consumption of alcohol, use of tobacco and level of physical activity. In effect, both the demand for, and financing of, health care depends partly on the demographic structure of a country.

Limitations

A few limitations of the study should be mentioned. First, the data utilized for this study were not obtained through the census information for the individual GCC countries. The GCC countries report sporadic census data, and for the years of their censuses only. We checked the data reported by the national statistics bureau of the GCC countries against the information provided by the World Bank. In all such cases, a match was found. In addition, the World Bank predicts the population for intercensus periods.

Secondly, the model could be unstable in predicting the adjusted population in non-GCC countries. We have used the same models to predict the adjusted population in regional countries outside of the GCC with stable population trends (Egypt, Jordan and Syrian Arab Republic). The results, not shown, indicated that the adjusted data matched the actual.

Thirdly, this study only adjusted the historical population and falls short of predicting future populations. Due to the fluctuations in the price of oil and gas and the fluctuations in the international financial markets, the rate of infrastructure construction is cyclical in the GCC. Thus, the importation of male labour to GCC countries is also cyclical. In addition, some GCC countries, including the UAE and Qatar and to a certain extent Bahrain, are developing medical tourism models to treat patients from abroad. This paper does not account for these exported services, because this goes beyond needs-based health-facility planning. Nevertheless, this study can be used to predict future modelled populations using the historical data as a baseline, and factoring economic and financial forecasts produced by each individual country.

Conclusions

The results in this paper can guide policy-makers in GCC countries to plan health-care facility expansions based on the actual needs of their economies, as based on robust population measurements. Failure to adjust for sex imbalances in the GCC countries would result in serious overestimation of the need for these countries to invest in health care, and would also invalidate benchmarking with other international comparisons. Policy-makers in the GCC can use these models to adjust for population in order to plan efficiently for expansions in the health-care sector and may use the adjusted heath-system indicators in planning for universal health coverage including migrant workers.

Competing interests: None declared.

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