Research article

Trends and projections of annual birth volumes in the State of Qatar: 1970–2025

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ABSTRACT
Background: The ethnic profile of Qatar is a combination of its indigenous peoples (Qataris) and non-resident foreigners (non-Qataris). Its population has increased dramatically during the last 30 years to around 1.9 m (although only 15% are Qataris) leading to an increase in the number of local births. A recent unexpected surge in births has lead to a need to re-evaluate the trends in birth numbers and develop more reliable predictions for both near- (2015) and far-term (2025) annual numbers of births to support the many healthcare planning initiatives which are currently underway.

Methods: There is considerable information already available in Qatar which can facilitate such a study. This paper collates these various data, charts and investigates their visible trends and develops a simple mathematical model which projects the annual number of births which might reasonably be expected to emerge later in this decade and beyond.

Results: The Qatari sub-population has maintained a reliable linear increase in birth numbers since data first began to be collected. The births among the non-GCC and Asian sub-populations are the primary cause of the recent nonlinear increase which can be well-described in the near-term by a simple quadratic curve. Far-term projections require a non-linear mathematical model which combines the regular linear increase among the Qataris with an exponentially decreasing demand for “in-Qatar” births from the non-Qataris. The trend for multiple births in Qatar (i.e. the annual number of live-born twins, triplets etc.) has shown significant increases during the last 20 years but may be reaching a plateau. Among Qataris the numbers have been higher but – at least for triplets and higher-order births – this gap has decreased in the last few years. It appears that the increase in multiple births has been associated with the current expansion of IVF programs and other forms of assisted conception in Qatar.

Conclusions: The annual number of births in Qatar has recently shown a significant departure from its previous trend, requiring a radical reassessment of future projections. There has also been a concomitant increase in multiple births which has been associated with the expansion of IVF programs and other forms of assisted conception. A simple quadratic model predicts that there will be ~22,500 births in 2015, of which ~8,000 will be Qatari. A far-term projection for 2025 suggests that this number is likely to rise to ~27,000 but with some small additional increase yet to come.

Keywords: Qatar, birth statistics, birth trends, multiple births, birth projections
INTRODUCTION

In common with most countries in the Arabian Gulf, the ethnic profile of Qatar has evolved to be a combination of its indigenous peoples (Qataris) and non-resident foreigners (non-Qataris), comprising both Arab and non-Arab expatriates from all over the world. The population in Qatar has increased dramatically throughout the last thirty years (Figure 1) and on April 30, 2013, it stood at 1,944,953 (excluding those who were outside the state boundary on that date), of which less than 15% were Qataris. Qatar is therefore a country comprising substantial numbers of different peoples with different biological propensities for different diseases and medical conditions, and who hold different opinions regarding the ideal nature and delivery of healthcare services. From an epidemiological perspective this situation is unique and such a demographic “perfect storm” complicates attempts to simply import North American or European healthcare models as a basis for the further development of the Qatari Healthcare system.

In parallel to the incessant increase in the overall population there has naturally been a corresponding increase in the number of in-country births, although this has perhaps been less dramatic because several sectors of the population (such as the migrant construction workers) are predominantly male and usually arrive in Qatar without any accompanying families. Nonetheless, the overall number of births has risen substantially during the last 30 years (Figure 2) and has become a clear and important “landmark” in the current wave of healthcare development. However, the predicted total annual number of births for 2015 which was estimated many years ago has already been surpassed by the unexpected surge in the number of births in the country. There is therefore a clear need to reevaluate the rationale for predicting anticipated annual birth numbers in Qatar and to develop more reliable numerical estimates which can be more confidently used to support the many healthcare planning initiatives which are currently underway.

There is a considerable amount of national data already available from several different sources within Qatar which can facilitate such a study. The purpose of this paper is to collate these various data, to chart and investigate their visible trends and to develop suitable future projections for the annual number of births which would be expected to emerge later in this decade and beyond.

METHODS

Data sources

The raw data presented here originate primarily from two local sources which are publicly available. The principal source is the set of annual reports of the Qatar National Births and Deaths Registry, which
are well-organized and extremely detailed annual summaries of the available birth and death data for Qatar. In recent years, these reports (and their relevant documentation) have all become available on the website of the Qatar Statistics Authority; the most recent report is for 2010. The ultimate source of these data are the official records of the Supreme Council of Health (note that some individuals do not register births in time and so these births are not registered during their year of birth). All births are registered according to the mother's usual place of residence at time of birth. Although the title, format and contents of this report have changed over the last 30 years, nonetheless much of the key data remains as an unbroken historical record. The first report of the National Births and Deaths Registry was released in September 1985 under the banner “VITAL STATISTICS: Annual Bulletin (Births and Deaths)”; this issue is particularly important because it also provides summary data for earlier years – as far back as 1970. The second data-source comprises the set of annual statistical reports which are prepared by the Qatar Hamad Medical Corporation (HMC) and made publicly available on its own website. These include birth statistics for the only two HMC hospitals which provide obstetric care (Women’s Hospital and Al Khor Hospital). Until recently, HMC was by far the main healthcare provider in Qatar and effectively the only inpatient facility available. Other local sources are available which can provide supporting data, especially the recent “PEARL” initiative – the new national neonatal registry.

Data entry and analyses
Selected data from the reports described above were entered into the JMP statistics package v8.0 (SAS Corp, USA) where they were collated and reorganized for presentation and analyses purposes. Presentation, comparisons and analyses of trends were then conducted using the Origin scientific plotting and analysis package v8.1 (Originlab Corp, USA). All curve-fitting and future projections were also carried out within Origin.

RESULTS
The increasing trend in registered births in Qatar between 1970 and 2010 is shown in Figure 3. These data are a composite of information from the annual Births and Deaths Reports of 1970–1984, 1989, 1997, 2007 and 2009, and a publicly-available Excel file from the Qatar Statistics Authority for 2010. It is evident that the indigenous population (Qataris) exhibit a gradual linear increase in birth numbers, whereas the expatriate population appears to experience two increased “waves” of births. The first of these runs from around 1977 to 1990 and the second from 2006 to the present. The small
number of “unregistered” births (i.e. births which are registered in subsequent years) between 1997 and 2010 are shown in Table 1 (along with the small but regular number of Qatari births abroad from 1993). There are no available data which describe non-Qatari women who may have been resident in Qatar during their pregnancy but decided to return home for the birth.

Qatars have the highest number of regional births throughout the recent recorded history of births in Qatar (Figure 4). “Other Arabs” and Asians form the next two largest sub-groupings, with the Asians displaying somewhat fewer births; their year-on-year variations also appear to track closely together throughout this period. It is of interest to note that—in contrast—very few GCC nationals have their babies in Qatar. The in-country births numbers for Europeans and “others” are also remarkably small.

Table 1. Annual numbers of unregistered births in Qatar7 and Qatari births abroad between 1997 and 2010. (Note that some data are not publicly available).

<table>
<thead>
<tr>
<th>Year</th>
<th>Qatari</th>
<th>Non-Qatari</th>
<th>Total</th>
<th>Qatari Births Abroad</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>187</td>
</tr>
<tr>
<td>1994</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>1995</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>176</td>
</tr>
<tr>
<td>1996</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>172</td>
</tr>
<tr>
<td>1997</td>
<td>162</td>
<td>28</td>
<td>190</td>
<td>177</td>
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<td>140</td>
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<td>64</td>
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<td>52</td>
<td>32</td>
<td>84</td>
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<td>2009</td>
<td>166</td>
<td>104</td>
<td>270</td>
<td>244</td>
</tr>
<tr>
<td>2010</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>276</td>
</tr>
</tbody>
</table>
The trends for multiple births (i.e. twins, triplets and higher-order births) in Qatar are visible in Figures 5 and 6 and display a high degree of year-on-year variability due to their relatively small numbers. Note that these data represent the number of individual babies who are twins or triplets (etc.) – they do not show the number of mothers who delivered. For analysis purposes, these data have been divided into two groups: twins (Figure 5) and triplets and higher-order births (Figure 6). It is clear from Figure 5B that although the absolute numbers of both Qatari and non-Qatari twin-births track very closely together throughout the period studied, when these are corrected for the increasing differences in their birth numbers, the Qataris show some evidence of having higher rate of twins since 1990.

However the difference between Qataris and non-Qataris is much larger with respect to the numbers of triplets and higher-order births (Figure 6A): although they begin at similarly low levels, their trends quickly diverge, with the non-Qatari births appearing to follow a more linear trend compared to the more complex trend exhibited by the Qataris. This difference is exacerbated when the relative numbers of annual births are taken into consideration (Figure 6B) although it appears to reach a maximum around 2000 and may subsequently decline slightly.

Until recently, almost all births in Qatar took place at the HMC Women’s Hospital (Figure 7), but since 2006, the annual number of births has also grown significantly due to additional contributions by the new (private) hospitals. In 2007, a second HMC hospital (Al Khor, in northern Qatar) also began to offer obstetric services, increasing the overall HMC number of births. However, in recent years the increase in births in the private sector has far surpassed the additional contribution of Al Khor. In 2010, the combined births from Al Ahli, Al Emadi and Doha Clinic constituted the visible difference between the registered total births and HMC total births, and in 2011 this amounted to 2,671.

We can make good use of these various data in the prediction of realistic national estimates of birth volume for both the near and mid-term future. From the registry data (Figure 8), it is clear that Qatari births exhibit a linear trend throughout. The parameters and standard-errors for the displayed regression line are: intercept = $-279176.93145$ (SE = 9456.29649) and gradient = $142.5621$ (SE = 4.73995). This gradual linear increase will produce an annual Qatari number of births of $\approx 8,000$ in 2015. Until 1997, the non-Qatari population has displayed less linear behavior, but for the next period of ten years, it did settle into a linear trend and this was used to project numbers forward, leading to a 2015 estimate of $\approx 18,000$. However, since 2006 the annual trend in birth numbers among the non-Qatari population has moved to a
new phase – a non-linear trajectory – which has significantly impacted the overall number of registered births in Qatar. For near-term projections (until 2015), this recent trend in registered births can be very closely approximated for the 5 years involved by using a simple quadratic equation. The parameters and standard-errors for the displayed regression lines are: Intercept = -3494.38500.0 (SE = 6966.2200.0), b1 = 346719.79985 (SE = 69386.70794) and b2 = -86.0 (SE = 17.27757).

Figure 5. Trend in Annual Numbers of Twins in Qatar (A: Absolute Numbers, B: Birth Percentages).
Unfortunately because there has been no public release of births and deaths reports since 2010, any near-term projections must be based on this relatively small portion of time. Nonetheless, the quadratic function shown in Figure 8 (dotted line) appears to be an excellent fit to these existing data. Therefore we can use this regression to project our near-term annual birth estimate for Qatar to 2015, when it will be \( \sim 22,500 \).

Near-term predictions assume that the composition of the Qatar population will remain relatively unchanged over this period while far-term projections require some assumptions regarding the
The dynamics of the expatriate population. These trends are shown in Figure 4 and strongly suggest that although Western populations may well have made significant inroads in Qatar during recent years, they have had little impact on birth numbers; the two expatriate populations that are likely to shape the dynamics of the birth population over the coming decade will probably remain “other Arabs” and Asians. The significant upswing in total births during the last 6 years appears to be primarily associated with these groups although it appears that the rise in these numbers is decreasing. If we assume that the increase in obstetric beds in Qatar is associated with the recent upsurge in private health care (which will be enhanced with the imminent opening of Sidra Women and Children's Hospital) then this will effectively continue to deplete the reservoir of local births from these two population subgroups.

We can then formulate a more “structural” predictive model for birth numbers which is likely to prove more robust for far-term projections. This model recognizes the gradual linear increase of the indigenous Qatari population but also includes a separate term which represents the larger expatriate

Figure 7. Trend Comparison of the Annual Numbers of Registered Births in Qatar, with the Corresponding Numbers at HMC and Subcategorized by Women's Hospital and Al Khor.

Figure 8. Near-Term Projection of Key Birth Statistics to 2015: Total Number of Registered Births and Number of Qatari Registered Births. (the green triangle is the 2011 estimate from the PEARL registry [8]).
sub-population which would be gradually depleted over the coming years, thereby reducing the
doubly illegal year-on-year increase and eventually forcing the number of new annual births to a plateau:

$$y = -a_0 + a_1 x + b_0 + b_1 \left(1 - \exp\left(-\frac{x - 2006}{T}\right)\right)$$

where $a_0$ and $a_1$ are the established Qatari intercept and gradient (see above),

- $b_0$ is the y-intercept at year 2006: 7347.26994 (1.61588)
- $b_1$: is the amplitude of the birth "reservoir": 11096.3131 (41.14453)
- $T$: Time constant of the depletion of the birth reservoir: 7.00006 (0.0352)

It was noted that fitting a nonlinear function with 3 unknown parameters to the small number of points
(5) beyond the linear region of the data (i.e. 2006–2010 inc.) might prove difficult. Therefore, since the
quadratic fit (above) proved to be such an excellent fit to the same region, the same quadratic curve
was sampled at 100 equally-spaced points and these were used as the basis for the nonlinear fit
(hence the small and misleading standard errors for the parameter estimates. This far-term model
predicts that the annual birth rate in 2025 could be as much as 27,000 (Figure 9).

DISCUSSION

Historical trends

Over the last 43 years the Qatari annual birth volumes have grown in a very linear fashion and it is likely
that by 2015 the annual number of Qatari births will have reached approximately 8,000. The total
annual volume, however (across all nationalities), has been more volatile because it is a strong
function of the expatriate population (in terms of numbers, age/gender and lifestyle). Roughly-
speaking, until 2006 the trend in the annual pattern of birth volume among the total population in
Qatar can be regarded as two large perturbations superimposed on relatively linear growth.

During the periods of linearity it appears that the expatriate birth population has been similar in size
to the Qatari birth population and growing at a similar rate. However between 1975 and 1990 the
expatriate births exhibited a significant "wave" of increased births which was followed by a rapid
decrease – possibly as a result of population upheavals during the first Gulf war. A much larger repeat
of this expatriate birth population "surge" would appear to be taking place now, having begun some
years ago during 2006. Linear regressions of early population growth models naturally predicted that
the total number of births in Qatar will reach approximately 18,000 per year by 2015.
Near-term projections

During the last five years it appears that Qatar has embarked on a significantly new (curvilinear) period of increased births. A more likely near-term (quadratic) estimate for the annual birth population would now be closer to 22,500 for 2015. Other functional forms of a near-term projection were explored but a simple quadratic fit appears to be the simplest and describes the available data with great precision. This model recently received some validation from the first published annual report of the PEARL project; when the national number of births for 2011 displayed excellent agreement with the previously estimated fit (Figure 8).

Multiple births

The general trend for multiple births in Qatar (i.e. the annual number of live-born twins, triplets etc.) has been increasing steadily since 1985, rising from just over 1% to ~3% in 2005. This is a little more than in the USA, where the number of live births in twin deliveries doubled between 1984 and 2005. By contrast, this rate in the more remote southeast region of China stayed roughly constant (averaging 1.2%) during the same period; this supports the notion that the increase in live twin births during this period is comparable to what is observed in “western” countries and can probably be ascribed to the expansion of IVF programs and other forms of assisted conception in Qatar.

Of special interest in the trends for multiple births in Qatar is the difference between the Qatari and non-Qatari numbers. The absolute numbers of twins appears very similar for both the Qatari and non-Qatari sub-populations, but when corrected for the associated changes in overall birth rate, a small discrepancy appears. In the case of triplets and higher-order births this difference is substantial and clearly visible both in the absolute and the corrected trends. It is tempting to simply believe that this reflects a preponderance of Qatars who make use of assisted conception opportunities in Qatar. However the HMC data available for 2011 would not – by itself – support this view. In 2011, the Assisted Conception Unit (ACU) at HMC treated 1,272 patients but only 45% of these were Qatars. Similarly, out of a grand total of 9,781 outpatient visits to the ACU in 2011, only 46% were by Qatars; furthermore, out of 288 female visits, only 31% were Qatari. Out of all the patients treated by the ACU in 2011, there were 335 clinical pregnancies of which 50% were for Qatars.

![Figure 10. Trend in Clinical Pregnancies in the HMC Assisted Conception Unit.](image-url)
The available historical data belies these recent statistics, demonstrating that – at least between 1998 and 2005 – there was actually a wide gap between the number of clinical pregnancies achieved by the ACU for Qataris and non-Qataris (Figure 10) – a gap that has since been completely closed during the last 5 years. However it is also clear from Figures 5 and 6 that this does not provide a complete explanation of the data because during the last five years there has still remained a substantial difference between the Qatari and non-Qatari multiple birth statistics. It may be that to find the answer to this question the statistics of those Qataris who seek treatment elsewhere will have to be explored further.

Far-term projections

Given the paucity of available data, attempting a far-term projection to 2025 is an ambitious task which is fraught with difficulties, in addition to the usual demographic problems associated with population variability. Because the population in Qatar mainly comprises expatriates, it is especially vulnerable to economic and political upheavals – both in their native countries and in the Gulf region itself. Qatar is also currently embarking on several major infrastructure projects, such as an ambitious rail system, the opening of the new Doha International Airport, hosting the future World Cup and the development of a plethora of new hotels. The implications of these events on birth numbers are difficult to estimate.

It should also be emphasized that although these statistics have strong planning value in the area of birth and newborn services, they might need to be supplemented to some extent for planning activities in the areas of maternity, pediatrics and some other services, since there are currently no reliable data concerning expatriate women who give birth in their home countries and subsequently return with the baby to Qatar. However, the projected estimate for 2025 of 27,500 births has been calculated by assuming that the linear trend in Qatari births will continue unabated and that the dynamics of the birth projection will primarily be governed by a gradually depleting annual reservoir of expatriate births (due to national increases in obstetrics facilities). Nonetheless, this estimate should be continually updated every few years.

REFERENCES