

Secular Trend of Height Variations in Iranian Population Born between 1940 and 1984

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Abstract

Background: Iran, a low- to middle-income country, has experienced considerable socioeconomic changes in 20th century, which their impacts on the adult heights has not been assessed deeply by now. This article aims to quantify the temporal variations of height (with respect to shrinkage of height due to aging) and its deterministic factors in Iranian population born between 1940 and 1984.

Methods: We analyzed the data of a large-scale national population- based survey that recruited 89,532 healthy subjects aged from 15 to 64 in 2005. Having used the Baltimore Longitudinal Study of Aging formulae, the shrinkage of height due to aging was adjusted. We modeled the estimated maximum height using multivariate regression analysis based on year of birth, sex, residing area and literacy. Moreover, we generated series of country maps showing the average of height classified by decades and provinces.

Results: On average, the height of Iranian population has increased around 1.28 cm per decade (1.17cm in females; 1.53cm in males). The most prominent jumps of male and female heights are observed in 1970s. However, the jump of height in women has occurred around 3.5-10 years later than in men.

Conclusion: We found a very sharp and clear increasing trend in height among those who were born between 1940 and 1984. Our findings support the fact that the socio-economical variations have had considerable impact on the maximum height of people; this can prove the population height measure as a good historical determinant for socio-economical development trend.

Keywords: Height, Secular trend, Socio-economical development, Iran

Introduction

The average stature of adults varies markedly from country to country, mostly due to genetics and socioeconomic determinants. Environmental conditions and childhood nutrition interact with the genetic factors. Since the genetic determinants are more or less constant within a large population, at least for a few decades, the temporal variations of adult heights within a population may reflect the long-term effects of socioeconomic changes.

It is well known that adult height declines with age (1, 2, 3). Therefore, adjusting for aging effect, greater height of younger cohorts may reflect their better nutritional status and other socio-economical determinates mainly during their childhoods. In other words, comparing the adjusted

height of adults in different age groups may imply the long-term changes of height because of socio-economical changes.

Iran is classified as a low- to middle-income country that has experienced considerable socioeconomic changes in 20th century, the impacts of which on the population health had not been explored deeply so far. The earliest economic policies aiming at planned economic development in modern Iran date back to 1925-41. These uncoordinated public policies, however, did not constitute development planning as the term has come to be understood after World War II. Overall, the prewar policies aimed at modernization, along with the more specific economic objectives of achieving industrialization and developing the country's

infrastructural facilities (4, 5). Although agriculture was historically the most important sector in Iran's economy, its share of the Gross Domestic Product (GDP) that is commonly used in economics as an indicator of country's standard of living has been declining since the 1930s due to the rise of manufacturing. During and just after the World War II, people lived under huge pressure since Great Britain and Soviet Union occupied areas of Iran to guard the oil fields against possible German encroachment. After the war, nationalization of oil (1950s), political and financial support of western countries, mainly the U.S., and economical growth led to an impressive rise in living standards and urbanizations up to late 70s. Islamic revolution in 1979, economic sanctions established by the U.S., and Iran-Iraq war in 1980 were some other significant events with deep effects on socioeconomic status of the people.

In our search, we could not find any solid evidence about the impact of socioeconomic changes on the height variations of Iranian population in recent decades.

In order to address to this question we explored a very large population-based dataset collected by the center for disease control with a sample size of almost ninety thousand adult Iranians. In this study, we decided to quantify the temporal variations of height between 1940 and 1984 adjusted for shrinkage of height due to aging effects.

Materials and Methods

Dataset We analyzed the data of a large-scale national population-based survey that recruited 89,532 healthy subjects aged 15 to 64 in 2005. The details of its methodology were published by the Ministry of Health and Medical Education of Iran in 2005 (6) and in a recently published article (7). In summary, Iranian National Communicable Disease (NCD) has set risk factor surveillance targets for five age groups: 15-24, 25-34, 35-44, 45-54, and 55-64. Target groups have been defined according to stepwise approach to non-communicable disease risk factor surveillance, and have been extracted from one of WHO global initiatives. A multi-stage random cluster sampling

method was used to identify the participants. The postal address of starting points for the survey in each cluster was determined centrally, using Iranian national zip code databank, and a clockwise movement from this point was used to ensure random approach to the households. In each cluster, 10 male and 10 female participants were approached to fulfill four eligible respondents from each age group. Trained male and female staff of medical universities/schools served as interviewers in pairs and a trained supervisor monitored the process in each district.

Standardized questionnaires were completed through interview and physical exams (8). Height was measured in upright position using standard measuring bars. Participants were asked to wear as light as possible and remove any kind of footwear and headgear, except for scarf or veil with light fabric that Iranian women usually wear as a religious mandate. Participants, who were not able to read and write, were reported as illiterate and the residents of rural or urban area were defined through the political classification of the living area.

We extracted the full dataset from the national surveillance site at Iran's center for disease control and rechecked the consistency of the data in the first step. All the subjects were included except those younger than 20 yr old and measured height with unacceptable range. It means that individuals with observed height below 100 and over 217 centimeters are those with too extreme measures and mostly created by data entry errors. It should be added that the dataset contains too many cases in a nationwide setting and the protocol of monitoring and evaluation followed very intensively.

Adjusting height for aging effect We systematically reviewed available papers that explored the impact of aging on height (1, 2, 9). Then we critically appraised their methodology and applications for Iranian population. The most important criteria, which were considered, are listed in Table 1. Neiewenweg et al. used Sorkine's formula and calculated the height standard deviation scores in a Netherlands' population. In con-

clusion, they mentioned that such formula could be used in other populations for age shrinkage adjustment (3). Therefore, we chose the Baltimore

Longitudinal Study of Aging formulae to adjust for the shrinkage of height effects due to aging (2).

Table 1: The most important characteristics of the three articles being critically appraised on the formulae for estimating the maximum height

Items Publication Year	Niewenweg et al.	Cline et al.	Sorkin et al.
	2003	1989	1999
Objectives	Calculate the height standard deviation scores (SDS) adjusted by secular trend and shrinking by using Sorkin's Formula	Based on a longitudinal study of Chronic Obstructive Pulmonary Disease.... Estimate the maximal stature based on sex, age and current height	To ascertain the pattern of adult height change as a function of age, compare the patterns for men and women
Population	Dutch Both Sex 21-85 yr old	White non-Mexican Americans	White , Baltimore , Maryland- an open cohort study of normative aging
Samples	Including 5 cross-sectional studies: male conscripts (1917) and four nationwide growth studies (1955,1965,1980 and 1997)	Stratified Cluster Sampling of Households with different Socioeconomic Statues Taking from 8 survey from 1972 to 1985 Age more than 20yr Both sex and at least 5yr follow-up n=3500 (483 had no follow-up and 703 subjects did have only 1 follow-up.)	Men and Women, 17-94 yr old, Baltimore Longitudinal Study of Aging , Start in 1958 with every 24 month for those aged 20-69, every 18 months for 60-69yr and annually for older ages. n= 1458 Well-educated, community dwelling, and in good health.

The formulae used to estimate the cumulative change of an individual's height based on sex and age are as follows:

Males: cumulative height change= $0.0435\text{Age} - 0.00009\text{Age}^2 - 0.000015\text{Age}^3$

Females: cumulative height change= $0.0714\text{Age} - 0.00075\text{Age}^2 - 0.000016\text{Age}^3$

Finally, the absolute cumulative height changes were added to the current height measure to calculate the maximum estimated height expected for each individual.

Statistical methods In our model, maximum estimated height of subjects is a dependent variable and year of birth, sex, current residential area (rural/urban) and literacy are considered as independent variables. In addition, we explored the interactions between year of birth and other variables to check if the temporal height variations

had a similar pattern in males and females, in rural and urban area residents and in literates and illiterates. In multivariate analysis, we entered all independent variables and their interaction terms. Those with statistical significant effects were kept in the final model. We checked the nonlinear temporal variations by entering quadratic term of year of birth.

To illustrate clearly the temporal and spatial variations, we used the maximum estimated height between 1980 and 1984 as the baseline level. In this way, contrasts were also maximized.

Results

We found a very sharp and clear increasing trend in height among those who were born between 1940 and 1984 (Fig. 1). In average, the height of

Iranian population has increased around 1.28 cm per decade -1.17cm in females; 1.53cm in males. Nonetheless, this pattern was not similar in males and females (the interaction term between the year of birth and sex: $P < 0.001$). The most prominent jumps of male and female heights were observed in 1970s. In a general observation, the jump of height in women had occurred around 3.5-10 yr later than men had.

Men were approximately 13 cm taller than women were. The mean heights for males and females were $170.27(\pm 8.05)$ and $157.20(\pm 7.22)$ cm respectively ($P < 0.001$). As mentioned before, the pattern of increasing height was not similar in women compared with men. Although in both sexes the trend is upward, men experienced more and faster rise in their height. (Table 2).

People, who lived in rural areas, were shorter than urban residents were. The mean values of men's height in rural and urban areas were $169.30(\pm 7.96)$ and $170.79(\pm 8.06)$ cm respectively ($P < 0.001$). In the same way, women who lived in urban areas were 1.14cm taller than rural ones ($P < 0.001$) (Table 2).

Furthermore, we found a significant difference in heights of literate and illiterate men and women

($P < 0.001$). The crude difference was about 2.94 and 3.65cm in women and men respectively, while the adjusted difference was 1.40 and 1.76 cm, but it was still significant ($P < 0.001$). This means that the literacy effect has been confounded by other variables such as year of birth and living area (Table 2).

As you can see in Fig. 2, the pattern of height increase was not similar in different provinces. Tehran, the capital city of Iran, had a taller population than other provinces in the 40s and 4 successive decades after it. In addition, the speed of increase in the height of Tehran's inhabitants had been more rapid than all of the other provinces of Iran between 1940 and 1984 had been. The speed of height increment has accelerated in the 60s after socio-economic reform of 1962 and has continued to 1984; however, this has not been a uniform pattern for all provinces. The two Eastern provinces seem to have a slower trend with a reverse pattern in one of them located in the south that is usually referred to as the most deprived province of Iran, after 70s. Generally, central provinces and a strip of coastal provinces on the Persian Gulf have enjoyed the most significant height increment trend after 70s.

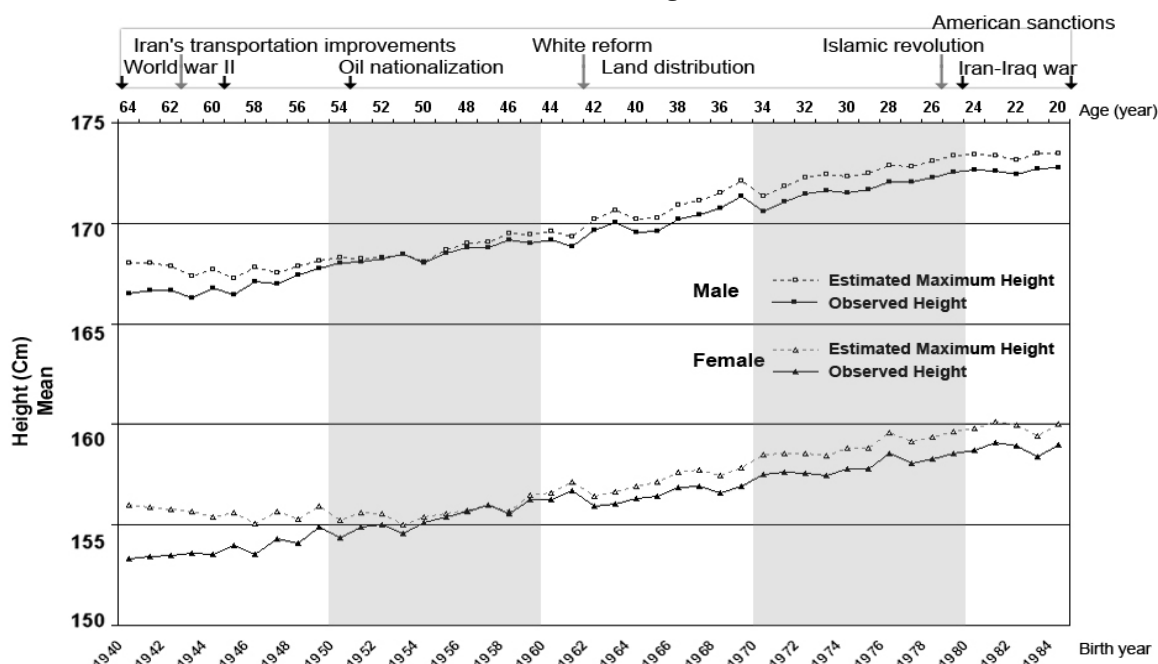
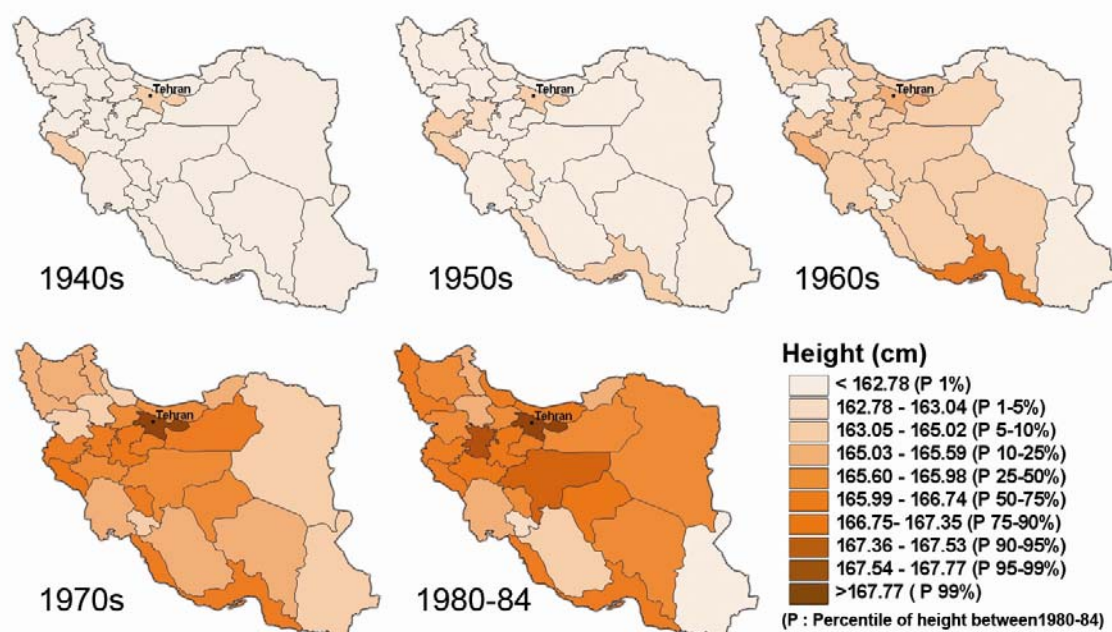


Fig. 1: The trend of height in Iran classified by gender according to some prominent historical events

Table 2: Effect of various factors on the estimated maximum height, by crude and adjusted coefficients

Variables		Women			Men		
		Max. Height (Mean±Se)	Crude Mean difference	†Adjusted Mean difference	Max. Height (Mean±Se)	Crude Mean difference	†Adjusted Mean difference
Birth yr	1940-49†	155.63±0.08	0	0	167.80±0.08	0	0
	1950-59	155.68±0.07	0.05	-0.25	168.78±0.08	0.97	0.65
	1960-69	157.17±0.075	1.49	1.16	170.62±0.08	1.84	1.60
	1970-79	158.97±0.07	1.80	1.55	172.52±0.09	1.90	1.76
	1980-84	159.87±0.11	0.90	0.79	173.39±0.13	0.87	0.80
Current living area	Rural‡	156.22±0.06	0	-	169.30±0.07	0	0
	Urban	157.73±0.05	1.51	1.14	170.79±0.05	1.49	1.13
Literate	No‡	155.35±0.06	0	-	167.35±0.09	0	0
	Yes	158.29±0.05	2.94	1.40	171.01±0.05	3.65	1.76

**Fig. 2:** Spatial distribution of height and its variation over five decades in Iran. (The height percentiles were calculated from those born between 1980-84)

Discussion

We found out that the height of Iranian population has increased between 1940 and 1984. On average, the height of people has increased around 1.32 and 0.91 cm per decade in men and women respectively; the minimum and maximum jumps were observed in 40s (0.05cm in women) and

70s (1.90cm in men), respectively. The jump of height in women has occurred around 3.5-10 yr later than men have. The literate people who live in urban areas are taller. Nonetheless, the temporal pattern is not similar all around the country. The Second World War 1939-1945 has had a significant catastrophic impact on socio-economi-

cal status of the entire world, including Iran. The socio-economic crisis of Iran in this period of history has been too severe and has been associated with frequent episodes of famine country-wide. We found in our results that the speed of rising height was much slower among those who were born in this period. Similar findings have been observed in different other countries worldwide. The Nordic children have been affected by World War II in terms of a transient reduction in temporal trends in height (10, 11). In a multi-national literature review on secular height trend, the most important results showed that the mean reported rates in height increases varied with age, socioeconomic status, and country, so caution must be exercised in drawing inferences. Nationalization of oil industry in Iran in 1951 made a great impact on the country's development after a few years of political conflicts inside the country and between Iran and Britain. The years after 1953, that was associated with some political establishment, stabilization of oil industry technology transfer from western countries to Iran, led to a fairly rapid development of the country. The so called White Reform of 1962, through which large farm lands were distributed and transferred to farmers, was another step forward to combat inequalities and distribution of wealth.

Our results show how these two important historical events has been accompanied by a rapid increment in the height of Iranians, which last for two decades until the end of the 70s. In early 80s, the quick upraising trend of Iranian's height increase faces a slow down phase and reaches an almost plateau state by 1984. Average height increase of Iranians from 1940 to 1984 has been 1.23 cm per decade, whereas, Tanner's estimate of birth cohort height increase is about 1 cm per decade (12). In a similar study, the average increase in height per decade was displayed to be 1.2 cm for males and 0.91 cm for females in Tucson, Arizona (9).

A constant male-female difference of 13 cm was observed in our findings; a similar finding has been resulted in a study based on mean height of Dutch

conscripts in 1917 and data from four consecutive nationwide growth studies (3).

This difference was observed in all birth cohorts and adjustment for the effects of literacy and living area did not significantly change this difference. These facts may reflect a constitutional difference between the two genders rather than a discrimination state.

It is supposed that social class of people has had a significant impact on the height of cohorts; however, this impact is diminishing as modern social condition is going to get established (13). We found that people who live in rural areas have had a shorter maximum height than urban residents have.

Furthermore, we found significant difference in heights of literates and illiterates. This can be described by the lower social class of rural inhabitants and illiterate population, especially in previous decades.

However, limitations of such a model should not be overlooked. We used Baltimore formulae to estimate maximum height, which is not completely coordinated with Iranian population. Nevertheless, like most other developing countries, there is no domestic cohort study, which models the effects of aging on height in Iran. Furthermore, some determining factors and their effect on height such as the living place and literacy could vary during the vast study period. For example, immigration from rural to urban areas may have some unpredictable effect on the results. In addition, the literacy level might change in some individuals even in late periods of their life. Therefore, the mentioned effect of such variables on maximum height would be somehow questionable.

In conclusion, the height variation has close relationship with historical events, which impose significant impact on economical condition of the country. However, taking into account the differences that exist in estimating maximum height values between the provinces; these results suggest that there were considerable social inequalities in Iran. Our findings support the fact that the socio-economical variations may have significant impact on the maximum height of people;

this can support the population height measure as a good historical determinant for socio-economical development trend.

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