# Trend of Blood Cholesterol Level in Iran:
# Results of Four National Surveys During 1991-2008

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**Abstract-** Trends in cholesterol level of different populations have been investigated in several studies. This study is conducted to determine the trend of cholesterol level of Iranian adults from 1990 to 2007. Data on cholesterol measurements of four national health surveys that have been carried out in Iran used in this study. Cholesterol level of 12728 adults aged 25-64 were measured in 1990-1 survey. Also in 1999, 2005, and 2007 surveys, blood cholesterol level of 18398, 52344 and 19630 have been sampled, respectively. The median of cholesterol were modeled with age for men and women separately for the four surveys using fractional polynomials. Then, trends in the median of cholesterol across these four surveys were studied. The analysis of cholesterol data over four national health surveys showed that the change in males' cholesterol level had a decreasing trend. This decreasing trend was more pronounced in ages younger than 45 years. However, the medians of cholesterol of females during 16 years of four national surveys had a varying trend. It was decreasing in ages younger than 45; but increasing in ages over 45 years. The median of the cholesterol level of males and females in 2005 survey was on average about 10 mg/dl higher in comparison with the other surveys. Our findings showed that the pattern of trend in cholesterol level of Iranian men and women adults have a considerable difference with those of the other developing and developed countries.
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**Keyword:** National Survey; Total Cholesterol; Trend

## Introduction

Out of 57 million worldwide mortalities in 2008, thirty three millions (%58) were due to noncontiguous diseases, among which the most important ones were referred as cardiovascular diseases, diabetes, cancer and chronic respiratory diseases (1). According to WHO, 43% of the diseases burden is related to noncontiguous diseases which will reach to 60% till 2020. Also, on the basis of their estimation, up to year 2020, 73% of the mortalities will be due to increasing non-contagious diseases. WHO further reports that 79% of this mortality cases and 85% of the diseases burden were occurred in low-income or middle-income countries (2). Iran is among 23 countries with low and middle-income which holds a high chronic diseases burden (1).

In addition, the ischemic heart diseases are among the most important risk of mortality worldwide. In developed and developing countries, ischemic heart diseases are the first and the third disease burden, respectively (3,4). High cholesterol level is an important risk factor for atherosclerosis and ischemic heart diseases (5). Hypercholesterolemia is the cause of about one third of the ischemic heart diseases. It is also estimated that it is responsible for almost 4.5% of total mortalities (2.6 million deaths) (6).

The hypercholesterolemia is the third risk factor of mortality in the world (5) also it is the fourth disease burden. Strikingly, lowering cholesterol level is able to lower the prevalence of cardiovascular diseases. For

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example, in a study, a 10% drop in cholesterol level of 40 years old men during a 5 year period could reduce prevalence of cardiovascular diseases by 50% (5). Therefore, high cholesterol level seems to be one of the most important modifiable risk factor of the non-contagious diseases. Conceivably, not only its value but also its trend in populations regularly should be studied.

Different studies around the world show changes in cholesterol level of population. In the United States, for example, cholesterol level of adults, children and adolescents has a downward trend (6,7). Decreasing trend in cholesterol level also is seen in Finland and North Africa (8,9). In contrast, a study in Japan showed an upward trend in cholesterol level (10). In aforementioned studies, it seems that the cholesterol trend follows different patterns based on the ethnicity and life style. This shows the importance of monitoring cholesterol in different communities. In Iran, hypercholesterolemia has been estimated to have a prevalence of 9.4% among men and 12.4% among women according to the 1999 survey (11). However, there has been no study to look at the trend of cholesterol level among Iranian population at national level. Therefore, a study of the trend of cholesterol is necessary for understanding the effects of life style, food regiment, community health program priorities and evaluation of national policies (12). In recent years, changes in life style of people such as rising immobility and consumption of fast food and subsequent obesity have altered the cholesterol level. However, no valid national study on trend of blood cholesterol in different ages and sex groups are carried out in Iran. This study is the first to use four national surveys data to look at trend in cholesterol in Iranian for further effective implementation of preventive programs of the noncontiguous diseases.

## Materials and Methods

### Implementation
The present study is designed on the basis of data from four national health surveys (1990-91, 1999, 2005 and 2007) in Iran to analyze trend in total cholesterol level of Iranian over a 16 year period.

### Data collection
#### National health surveys 1990-91 and 1999
The two Iranian national health surveys 1990-91 and 1999 included blood cholesterol measures of about 14000 and 18500 individuals aged 25-64 years. In these surveys, sampling fraction were 1/1000 of the total

metropolitan and rural population which were carried out by undersecretary of research of Ministry of Health and Medical Education with collaboration of universities of medical sciences and blood transfusion organization over the country provinces. It is worth mentioning that in both surveys, the sampling scheme were random cluster sampling of households comprising people aged 2-69 years. The data of measured cholesterol of the individuals aged 24-69 were used in these two surveys. The first national health survey was conducted during June 1990 until March 1992. The second one was performed during April 1999 to February of 2000.

#### National surveillance of risk factors of non-communicable diseases 2005 and 2007
The first round of National Surveillance of Risk Factors of Non-Communicable Diseases *i.e.* the third countrywide survey was done in 2005 on 89000 people aged 15-64. Blood cholesterol of 52500 Iranian citizens aged 25-64 years was measured in this survey and individuals aged 15-64 were questioned and also underwent some physical assessments. However, blood biochemical tests such as cholesterol measurement were taken from those who were aged 25-64 years.

The second round of National Surveillance of Risk Factors of Non-Communicable Diseases (NCD) *i.e.* the forth countrywide survey was carried out in 2007 on 30000 people aged 15-64. The blood cholesterol of 20000 Iranian aged 25-64 was measured in this survey. These two surveys were designed on the basis of step by step instructions of WHO (13) with collaboration of 40 countrywide medical schools. All participants were taken orally informed consent.

### Data collection methods of NCDs
In both surveys, the data were collected in three steps. In the first step, health indices and demographic information were gathered through a standard questionnaire. In the second step, physical exam and anthropometric parameters such as height and weight were measured. In the third step, venous blood samples were drawn from 10-12 hour overnight fasting participants. If the participants were not available in the next two follow-up blood sampling, they were excluded. The three steps are explained below.

#### First step: behavioral assessment and demographic information
The questionnaires used in two rounds of National Surveillance of Risk Factors of Non-Communicable Diseases of 2005 and 2006 as well as in the other two

rounds of national health surveys during 1990-91, 1999 were designed based on WHO guidelines and completed by the trained interviewer. The questionnaires contained 6 sections: demographic information, 24 hour dietary recall, leisure-time physical activity, smoking behavior, and medical history such as hypertension and diabetes. Demographic information consisted of age, gender, education, occupation, insurance coverage, province of residence, and residency area (metropolitan/rural).

### Second step: physical exam

Height and weight of participants were taken in light clothing with bare feet in this step. Weight was measured with electronic portable calibrated balance. The height was recorded in centimeter.

### Third step: biochemical analysis

Ten ml fasting venous blood was drawn from the participants in sitting position and conveyed to a 4 ml test tube for instantaneous centrifuge. The plasma samples were taken to the reference laboratory of the province health ministry upon cold chain storage. Plasma total cholesterol of one test tube was measured with enzymatic method using Pars Azmoon kit. For quality control, 10% of all samples were sent to a WHO certified reference lab in Tehran. It is worth mentioning that the interviewers were sent to the eligible participants' house two days before blood sampling to identify qualified individuals, complete questionnaires and to take consent.

### Sample size

As mentioned above, the sample size of each of the two national health surveys 1990-91 and 1999 consisted of 1/1000 of the total metropolitan and rural country population of that time. Consequently, in these surveys, cholesterol levels of 12728 and 18398 individuals aged 25-64 years were recruited, respectively. National Surveillance of Risk Factors of Non-Communicable Diseases has been designed according to age and sex composition. WHO suggested to survey 1000 individuals in each province. Primarily, in each province 50 clusters were planed to be surveyed, comprising 20 individuals (10 men and 10 women) living in the neighboring households. Each of the 10 men or women were supposed to be in age groups of 15-24, 25-34, 35-44, 45-54 and 55-64 years. Thus, two men and two women were recruited from the above five age groups in each cluster. The first subject of a cluster was identified randomly based on postal addresses. Fortunately, in National Surveillance of Risk Factors of Non-

Communicable Diseases of 2005, the sample size in each province was more than a thousand. Total cholesterol measures of 52344 and 19734 individuals aged 25-64 years obtained from two National Surveillance of Risk Factors of Non-Communicable Diseases 2005 and 2007 were used in this study.

### Statistical analysis

Because of the sampling methods of 2005 and 2007 surveys, primarily, "weights" for each sex and age groups were assigned according to the distribution of sex and age groups of the 2006 national census in each province. The logarithmic transformation was applied to the total blood cholesterol data to become nearly normally distributed. After modeling, the data were transformed back to original scale using the exponential function.

First, the median of the total blood cholesterol were modeled with age separately for metropolitan and rural men and women using the fractional polynomial model. Second, the relative differences of the medians cholesterol for each year of age of urban and rural men and women were computed in order to decide whether the urban and rural data could be combined. Then, after combining urban and rural data for each sex, models of the median of blood cholesterol level for each of the four surveys was obtained. Finally, on the basis of the differences of these models the trend in cholesterol level over the period of 1990 to 2007 was studied for men and women, separately.

Since the sampling structure of the 2005 and 2006 surveys was age and gender adjusted, its structure was introduced in all analysis using the SVY (Survey Data Analysis) command in STATA (11.0) software. Then, Fracpoly procedure employed in this software to obtain the appropriate models of the median of logarithm of cholesterol with age for each sex in all four surveys. Finally, the exponential function used to transform back the fitted models to the original scale.

## Results

In national health surveys 1990-1, total cholesterol level of 5542 men (43.5%) and 7186 women (56.5%) aged 25-64 (total 12728) from all provinces in Iran were modeled with age, separately. The mean (± SD) of relative differences of the median cholesterol for each age of men and women in metropolitan and rural areas were 1.7±0.9 and 2.1±1.3 percent, respectively. As the differences were small, we decided to combine the urban and rural data for the purpose of study of trend in

cholesterol level of men and women. Also, after combining the urban and rural data for men and women in order to see what is the effect of provincial variation in average cholesterol level over all ages in a regression model we entered the provincial differences as a fixed factor with age. Then, from these models estimates of the average of cholesterol level for all ages for each province were derived and for each province the relative difference from country average were computed. Mean (± SD) of provincial relative differences for men and women were observed to be only 9.5±8.9 and 8.8±8.9 percent, respectively. These averages of variations across 30 provinces of the country for the aim of the study of trend of cholesterol deemed to be ignorable and therefore the median of cholesterol with age were modeled for men and women separately for 1990-1 survey.

The national survey of 1999 included cholesterol measurements of 7878 (43.8%) men and 10520 (57.2%) women all over Iran. Similar analyses as explained for 1990-1 survey was carried on 1999 survey and showed that the mean (± SD) of relative differences of the median cholesterol for each age of men and women in urban and rural areas were 4.4±2.3 and 2.1±1.3 percent, respectively. When we combined the urban and rural data for each sex, the regression analyses showed that corresponding age-province average of relative differences were 6.2±4.3 and 6.1±4.3 percent,

respectively. So, we decided to model the median of cholesterol with age for men and women separately for 1999 survey pooling data from provinces across the country.

The two National Surveillance of Risk Factors of Non-Communicable Diseases 2005 and 2007 included cholesterol measurements of 25138 (48.0%), 27206 (52.0%) and 9369 (47.7%), 10261 (52.3%) men and women, respectively. The mean (± SD) of relative differences of the median cholesterol for each age of men and women in urban and rural areas for the two surveys were 1.4±0.8, 1.0±0.6 and 3.6±1.1, 4.0±1.0 percent, respectively. And when we combined the urban and rural data for each sex, analyses indicated that the corresponding age-province average of relative differences for these two surveys were 3.1±2.2, 2.8±2.3 and 4.1±3.1, 4.5±3.8 percent, respectively. Consequently, for the purpose of study of trend, median of cholesterol with age were modeled for men and women separately for 2005 and 2007 surveys.

**Trend in total cholesterol level of men over the four surveys**

The median cholesterol of men with age were modeled for each of the four surveys 1990-1, 1999, 2005 and 2007 separately using fractional polynomials and are shown together in figure 1 also table 1.
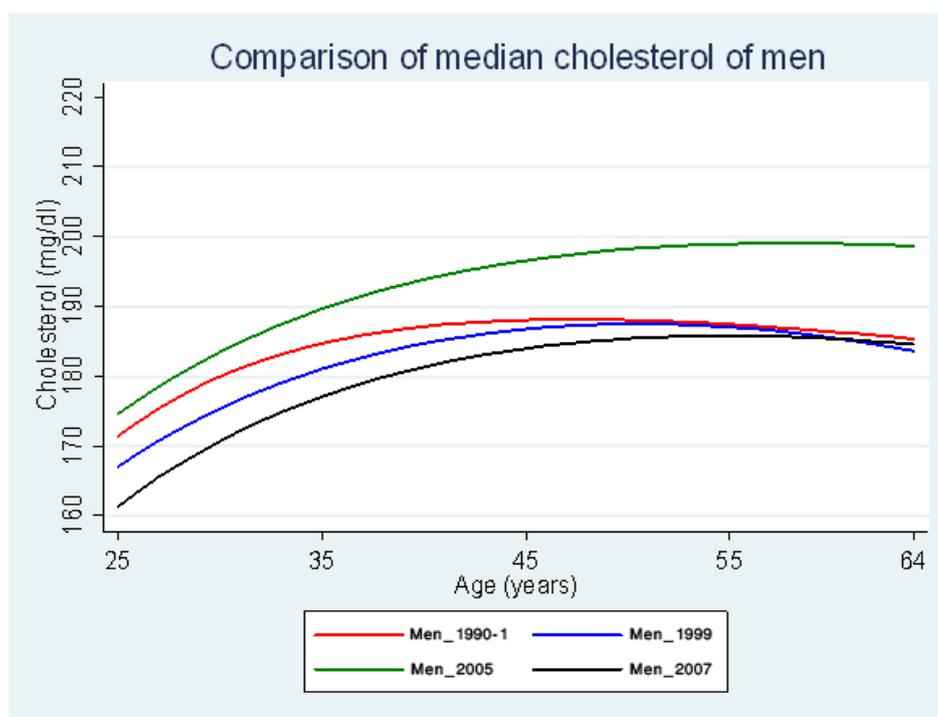


**Figure 1.** Trend in median cholesterol level of Iranian men in surveys 1990-1, 1999, 2005 and 2007.

**Table 1.** Medians of cholesterol level of men and women according to age and year of national health survey.

| Age (years) & Year of study | Men Median of cholesterol level (mm/dl) | | | | Women Median of cholesterol level (mm/dl) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990-1 | 1999 | 2003 | 2007 | 1990-1 | 1999 | 2003 | 2007 |
| 25 | 171.4 | 174.6 | 167 | 171.4 | 178.6 | 169.1 | 174.1 | 179.1 |
| 26 | 173.5 | 176.6 | 169 | 173.5 | 179.6 | 170.1 | 174.8 | 179.2 |
| 27 | 175.4 | 178.5 | 170.8 | 175.4 | 180.6 | 171 | 175.5 | 179.4 |
| 28 | 177.1 | 180.3 | 172.4 | 177.1 | 181.6 | 172 | 176.3 | 179.6 |
| 29 | 178.6 | 181.9 | 174 | 178.6 | 182.7 | 173 | 177.1 | 179.9 |
| 30 | 179.9 | 183.5 | 175.4 | 179.9 | 183.8 | 174.1 | 177.9 | 180.3 |
| 31 | 181.1 | 184.9 | 176.7 | 181.1 | 184.9 | 175.2 | 178.7 | 180.6 |
| 32 | 182.2 | 186.2 | 177.9 | 182.2 | 186.1 | 176.3 | 179.5 | 181.1 |
| 33 | 183.1 | 187.4 | 179 | 183.1 | 187.3 | 177.4 | 180.4 | 181.5 |
| 34 | 184 | 188.6 | 180.1 | 184 | 188.6 | 178.6 | 181.3 | 182 |
| 35 | 184.7 | 189.6 | 181 | 184.7 | 189.8 | 179.8 | 182.2 | 182.6 |
| 36 | 185.3 | 190.6 | 181.9 | 185.3 | 191.1 | 181 | 183.1 | 183.1 |
| 37 | 185.9 | 191.5 | 182.7 | 185.9 | 192.4 | 182.2 | 184.1 | 183.7 |
| 38 | 186.4 | 192.4 | 183.4 | 186.4 | 193.8 | 183.5 | 185 | 184.3 |
| 39 | 186.8 | 193.1 | 184.1 | 186.8 | 195.1 | 184.7 | 186 | 185 |
| 40 | 187.1 | 193.9 | 184.7 | 187.1 | 196.5 | 186 | 186.9 | 185.7 |
| 41 | 187.4 | 194.5 | 185.2 | 187.4 | 197.9 | 187.3 | 187.9 | 186.4 |
| 42 | 187.7 | 195.1 | 185.7 | 187.7 | 199.3 | 188.6 | 188.9 | 187.1 |
| 43 | 187.8 | 195.7 | 186.1 | 187.8 | 200.6 | 189.8 | 189.9 | 187.8 |
| 44 | 188 | 196.2 | 186.5 | 188 | 202 | 191.1 | 190.8 | 188.6 |
| 45 | 188.1 | 196.6 | 186.8 | 188.1 | 203.4 | 192.4 | 191.8 | 189.4 |
| 46 | 188.1 | 197 | 187 | 188.1 | 204.8 | 193.7 | 192.8 | 190.1 |
| 47 | 188.2 | 197.4 | 187.2 | 188.2 | 206.2 | 194.9 | 193.7 | 191 |
| 48 | 188.2 | 197.7 | 187.4 | 188.2 | 207.5 | 196.1 | 194.6 | 191.8 |
| 49 | 188.1 | 198 | 187.5 | 188.1 | 208.9 | 197.3 | 195.5 | 192.6 |
| 50 | 188.1 | 198.2 | 187.5 | 188.1 | 210.2 | 198.5 | 196.4 | 193.5 |
| 51 | 188 | 198.5 | 187.5 | 188 | 211.5 | 199.6 | 197.3 | 194.4 |
| 52 | 187.9 | 198.6 | 187.5 | 187.9 | 212.7 | 200.7 | 198.1 | 195.3 |
| 53 | 187.8 | 198.8 | 187.4 | 187.8 | 213.9 | 201.8 | 198.9 | 196.2 |
| 54 | 187.6 | 198.9 | 187.2 | 187.6 | 215.1 | 202.8 | 199.7 | 197.1 |
| 55 | 187.4 | 199 | 187.1 | 187.4 | 216.2 | 203.8 | 200.4 | 198 |
| 56 | 187.3 | 199 | 186.8 | 187.3 | 217.3 | 204.6 | 201.1 | 198.9 |
| 57 | 187.1 | 199.1 | 186.6 | 187.1 | 218.2 | 205.5 | 201.8 | 199.9 |
| 58 | 186.9 | 199.1 | 186.3 | 186.9 | 219.2 | 206.2 | 202.4 | 200.9 |
| 59 | 186.6 | 199.1 | 185.9 | 186.6 | 220 | 206.9 | 202.9 | 201.8 |
| 60 | 186.4 | 199 | 185.5 | 186.4 | 220.8 | 207.5 | 203.4 | 202.8 |
| 61 | 186.1 | 199 | 185.1 | 186.1 | 221.5 | 208 | 203.8 | 203.8 |
| 62 | 185.9 | 198.9 | 184.6 | 185.9 | 222.1 | 208.4 | 204.1 | 204.8 |
| 63 | 185.6 | 198.8 | 184.1 | 185.6 | 222.6 | 208.8 | 204.4 | 205.9 |
| 64 | 185.4 | 198.6 | 183.6 | 185.4 | 223 | 209 | 204.6 | 206.9 |

As figure 1 shows the pattern of change of the average cholesterol for three surveys 1990-1, 1999 and 2007 are similar; however are different from 2005 survey. For the three surveys 1990-1, 1999 and 2007, up to the age of 45 years, average cholesterol is steadily increases with age although between ages 45 to 64 years is approximately constant for 2007 survey and slightly diminishes for 1990-1 and 1999 surveys. As one can see in the figure 1, the average cholesterol during 1990-1 to 2007 (except for the 2005 survey) decreased. The average decrease over these years for ages 25 to 45 years was 7.6±3.2 mg/dl. The corresponding decrease for the ages 45 to 64 years was 2.0±1.05 mg/dl.
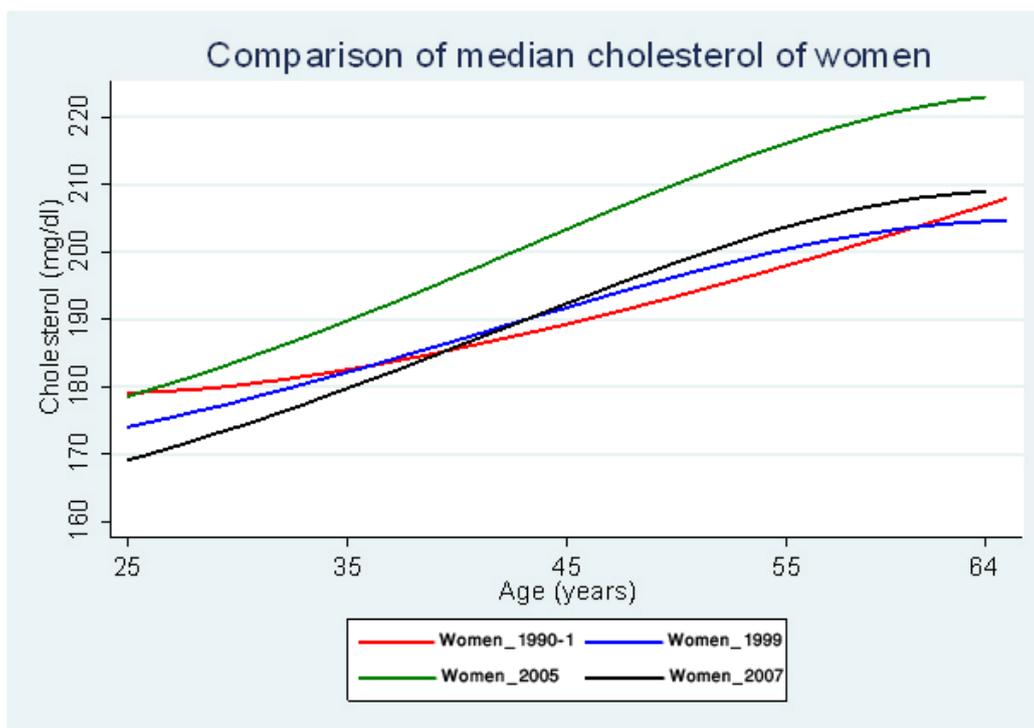
**Figure 2.** Trend in median cholesterol level of Iranian women in surveys 1990-1, 1999, 2005 and 2007.

The median cholesterol of men for year 2005 data increases with age up to age of 55 years and is approximately constant afterwards although on average is about 10.0 mg/dl higher than the other data. The corresponding average differences for 1990-1, 1999 and 2007 surveys were 8.2 mg/dl, 10.3 mg/dl and 13.0 mg/dl, respectively. Difference in older age for the 2005 data and the other surveys are quite noticeable. However, increase in median cholesterol level with age slows down for all of the four surveys but for 2005 data is not different from the other data. For year 2005, the level of cholesterol after 55 years is stable and is about 200 mg/dl but for the other data decreased to about 185 mg/dl at age 64 years (Figure 1).

**Trend in total cholesterol level of women over the four surveys**

Fractional polynomials used to model the median cholesterol of women with age for each of the four surveys 1990-1, 1999, 2005 and 2007, separately. The corresponding models for the women are shown in figure 2 and table 1. As figure 2 shows the pattern of change of the average cholesterol for two surveys 1999 and 2007 are somewhat similar to the 2005 data except that of the 2005 data is on average about 11.0 mg/dl

higher. The corresponding average difference with 1990-1, 1999 and 2007 data was 11.9 mg/dl, 11.53 mg/dl and 11.2 mg/dl, respectively.

According to the models, the pattern of change of the median cholesterol for women in year 2005 is different from the other data. The median cholesterol was approximately about 184 mg/dl between 25 to 35 years and increased afterwards. The rate of such increase was higher than those in other data after age of 55. Apart from differences in the level of average cholesterol of women in four surveys, they were increasing with age up to the age of 64 years.

The medians of females' cholesterol level over these 16 years in the four national health surveys had a varying trend. It was decreasing in ages younger than 45 (on average 3.3 mg/dl); however increasing (4.6 mg/dl) in older ages.

## Discussion

The present study investigated the trend in total cholesterol level of men and women during 1997 to 2007. Total cholesterol level of Iranian men in all age groups has a downward trend with a noticeable decrease in younger ages. Also, over this period, the total

cholesterol level among Iranian women younger than 45 years showed trivial changes. Increased total cholesterol level of women older than 45 is a worrying finding. Upward trend of total cholesterol among women older than 45 during 16 year trends is a matter of concern since hypercholesterolemia during this age span makes the women more susceptible to cardiovascular diseases.

Menopause accrued to be around age of 50 years among Iranian women and this coincides with high prevalence of cardiovascular diseases (14). Total cholesterol of the Iranian women had more changes than that of the Iranian men. Although 16 years trend of total cholesterol of men have shown an upward soar, it has a considerably lower increase in women. This observation highlights more attention to the older women's cholesterol especially women over 50.

A worldwide study of trend in total cholesterol has shown that the pattern of this trend for adults aged 25 and older is different around the world. In this study, Farzadfar *et al.* looked at the change in total cholesterol of 3 million people aged 25 and older from 199 countries during 1980 to 2008. This study indicated that during this period minimal change in total cholesterol level of only 0.1 mmol/l (3.86 mg/dl) for each decade were seen in both sexes. According to Farzadfar *et al.*, developed countries with high income showed a downward trend in the total cholesterol level. These countries consisted of Australia, North America, West, East and Central Europe with 0.2 mmol/l (7.73 mg/dl) change for each decade (12). On the contrary, mean total cholesterol of East and South East of Asia and Atlantic Ocean had upward trends with an average increase of 0.08 mmol/l (3.09 mg/dl) and 0.09 mmol/l (3.48 mg/dl) for each decade in total cholesterol level of men and women, respectively. It is worth noting that based on the findings of Farzadfar *et al.* study, there is no significant changes in cholesterol level between age-adjusted groups (12).

Comparison between Farzadfar *et al.* and our findings showed that the trend in cholesterol in Iran is rather unique. The trend of total cholesterol level during 1990-1 to 2007 showed that total cholesterol among Iranian men had a mean decline of 4.8 mg/dl which is very close to those obtained from Farzadfar *et al.* (3.86 mg/dl for each decade). But, this value for the Iranian women during the same period has been 0.64 mg/dl increase which is incongruent with Farzadfar *et al.* findings.

This study showed that during 16 years total cholesterol of Iranian men younger than 45 declined about 7.6 mg/dl. Such decrease for men aged over 45

was only 2 mg/dl. These figures for women under 45 were 3.3 mg/dl decrease as oppose in women aged over 45 which was 4.6 mg/dl. Therefore, trend in total cholesterol among younger Iranian women (under 45) has been similar to the developed countries, whereas, total cholesterol trend pattern of older Iranian women (aged over 45) resembles the East Asian and the South East Asian countries. The pattern of trend in cholesterol of Iranian women was unique, but pattern of change in men cholesterol resembles the developed countries. This implies the differences between our cholesterol indices with other countries and necessitates much more attention on local norms.

Carrol *et al.* reviewed six cross sectional surveys carried out in United States during 1960 to 2002 and showed that the trend in cholesterol level was downward. They observed that mean total cholesterol of American men and women aged 20 to 70 reached from 220 mg/dl and 225 mg/dl in 1996 to 203 mg/dl and 202 mg/dl in 2002, respectively. They also showed that total cholesterol level increases steadily in men up to the age of 50 and then remains unchanged or even decreased across some time spans. Although for women aged 50 and older, the cholesterol level increased with age, its speed slows down (15).

As can be seen, upward trend of cholesterol with age has a similar pattern among American and Iranian. But unlike Iranian, decrease in cholesterol is higher for ages over 50 amongst Americans. The noticeable decrease in total cholesterol among people aged over 50 represents greater attention of the American health care system to the older who are more susceptible to cardiovascular diseases than the younger (15).

In another study, Arnett *et al.* looked at 5 American cross-sectional surveys during 1982 to 2002, and showed that mean total cholesterol level had a downward trend. The mean total cholesterol of American men and women in 1982 were 211.9 mg/dl and 207.6 mg/dl respectively where decreased to 199.2 mg/dl for men and 196.5 mg/dl for women in 2002 (16). Moreover, there have been substantial differences in total cholesterol changes between different age groups. This study also showed a noticeable decline in total cholesterol among middle-age and older in the US, however this decrease was minimal among younger or even in recent years it has been some soaring trend. Still, based on Arnett's findings decrease in American men and women total cholesterol level were higher than in Iranian. This implies some improvement in nutrition among American compared with Iranian (16).

Therefore, Iranian health and treatment policy

makers should find ways to improve social nutritional status and systematize a proper nutrition culture till the downward total cholesterol trend goes on and reaches an ideal level. This will help to strikingly decrease the cardiovascular disease burden on health and treatment system.

Vartiainen *et al.* in their study on five cross sectional studies conducted on adults aged 30-59 years old between 1972 and 1992 (1972, 1977, 1982, 1987 and 1992) in Finland showed that total cholesterol of Finnish men has been dropped about 36 mg/dl (ranged 30.5 to 41.4 mg/dl) during 20 years which is noticeable (17). This study also reported a 46 mg/dl (variation range of 43.7-48.3 mg/dl) drop in Finnish women total cholesterol which is 10 mg/dl higher than the Finnish men. Vartiainen *et al.* believed that having more unsaturated fat and low fat milk and dairy products are the most important reducing factors of total cholesterol among Finnish men and women. The lack of studying the trend in cholesterol variation in different age groups is one of the limitations of Vartiainen *et al.* study since variation in cholesterol level may substantially influence by the age.

Another Finnish study by Jousilahti *et al.* who used the five aforementioned cross sectional studies confirmed Vartiainen *et al.* findings and showed a downward total cholesterol trend in all age groups. However, they depicted an age related upward trend of total cholesterol in women. Moreover, Jousilahti *et al.* reported an upward trend of total cholesterol up to 45 years old in men but then it flatten or even decrease over 45 years. In contrast, total cholesterol of Finnish women has an upward age related trend with slower increase above 55 years (18). Compared with Finnish, the Iranian population experienced less decrease in total cholesterol, although the pattern of its variation among men and women during 16 years is similar.

A cohort study based on 6 surveys in Japan has evaluated change in nutrition and trend in serum total cholesterol during 50 years (19). This survey which focused on men aged 40-64 during 1958 up to 2009 showed that serum total cholesterol level has drastically increased from 152.5 mg/dl in 1958 to 207.7 mg/dl in 2009. The authors believed that this soar in total cholesterol level is due to nutritional change from sea food to European food regime in Japan (19). So, the trend in total cholesterol of Iranian and Japanese are different. Although the present study showed total cholesterol of Iranian men during 16 years has been decreased, educational programs for lowering cholesterol should be designed as we see in Japan

change in nutritional habit to fast food regimen may reverse the trend.

Like Iranian, high cholesterol change is seen among Chinese men and women aged 20 to 50 years old. Although the trend is downward among the Iranians, the Chinese had upward trend. Interestingly, for older than 70 years, their total cholesterol concomitantly increase with age (6). This implies the potential difference of age adjusted cholesterol pattern of change for over 70 years and the needs for ongoing studies to look at this in Iran.

Gupta *et al.* in their study reviewed four cross sectional studies during 1993 to 2005 in India looking at risk factors of coronary heart disease risk factors in people aged 20 and older. Their findings showed that mean of total cholesterol in Indian metropolitan communities in 1993 was 174±45 mg/dl which reached to 193.5±39 mg/dl in 2005 resulting about 20 unit increase (20). Therefore, change of cholesterol between Iran and India is different which may be due to difference in food regimes between two countries.

Tehran lipid and glucose survey over 3.5 years (two studies 1998-2001 and 2002-2005) found that total cholesterol of 5618 participants aged 20 and older decreased in both sexes (21). They found a noticeable fall of 32.1 mg/dl for men and 30.2 mg/dl for women. This finding is limited to a small area (district number 13) in Tehran and can not be generalized. Also, as this survey was only based on two cross sectional studies, the short follow up may be one reason for this drastic drop during this short period of time and long term surveys can be complementary. In conclusion, the decreasing trend in total cholesterol of Iranian men is similar with that of the developed world but the change in total cholesterol of women is unique. It was decreasing in ages younger than 45 years but increasing in older ages. In general, during 1990-1 to 2007, the highest cholesterol variations in Iranian occurred in younger ages so as to men total cholesterol level in ages over 45 has been rather unchanged, however, total cholesterol of women over 45 has been incremental. Since the women are more susceptible to cardiovascular diseases during menopause or nearly 50, this upward trend is an alarm for the Iranian health policy makers and necessitates more attention.

In addition, the nutritional habit of Iranian is changing toward fast food consumption, which this unfortunately potentiate high cholesterol and risk for cardiovascular diseases. Therefore, preventive measures should be taken to improve the nutritional status of the Iranian and further repetitive and regular studies over the country are inevitable.

## Acknowledgment

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