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Twenty-year dynamics of hypertension in Iranian adults; Age, Period and Cohort analysis

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Abstract:

Background: Hypertension is a well-known health problem all over the world. Many studies have assessed its prevalence and associated risk-factors, but all were cross-sectional and did not evaluate the trend of hypertension through all three different temporal dimensions including age, period and cohort (APC). So we aimed to assess the twenty-year dynamics of hypertension via the APC model.

Methods: Data from 74,155 subjects aged 25-60 years, gathered through five national health surveys (1990-91, 1999, 2003, 2007 and 2011) were used in this study. The APC effect on hypertension was analyzed using the Intrinsic Estimator model.

Results: The prevalence of hypertension increased with age for both genders except for males in 2003 and 2011 periods with drops of 3.5% for ages 55-60 and 8.1% for ages 50-60, respectively. As for the period effect, the prevalence of hypertension was almost constant in all age groups for both genders from 1990-1999. The cohort-based prevalence of hypertension showed a declining trend in all cohorts for females except for 2011 in birth cohort of 1950-1955 which remains stationary. The trend of prevalence for males also follows a decreasing trend except for periods of 2003, 2007, and 2011, birth cohorts of 1945-1949, 1975-1980 and 1950-1960 increase by 3.5%, 1.9%, and 8.1%, respectively.

Conclusion:
The age effect on the prevalence of HTN showed an almost monotonic increasing trend. The period effect increased the total prevalence of hypertension from 1992 to 1997. The cohort effect also showed a monotonic decrease in HTN prevalence except for a few discrepancies.

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Introduction

Hypertension as a well known major independent risk factor for cardiovascular disease and stroke (1) has had great impact on health outcomes and disparities (2-5). It is an adjustable risk factor accountable for 13.5% of the premature deaths and 6% of the total global DALYs (6-8). Based on the cut off values presented in the seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure (9), in 2007, 26.4% of the adult population were estimated to fall into the hypertensive category (10). Although its prevalence varies worldwide, there is strong evidence pointing toward a global outbreak of hypertension, mainly due to the changes in lifestyles. With the continuous growth and aging of the world population, hypertensive group is predicted to expand from 1 billion worldwide, to 1.56 billion by 2025 (11).

Developing countries such as Iran are of no exception. Data from our country also shows similar results regarding the prevalence of hypertension. It was detected in 25% of the population aged 16 to 64 in 2007 (12). One year later another survey reported a prevalence of 23% for adults aged 30 to 55 and 50% for the population aged over 55 (13). Obesity, physical inactivity, stressful environment and high sodium dietary habits are well known variables affecting blood pressure (13). The rise in the prevalence of these variables has occurred mainly due to the adoption of western lifestyles and urbanization in developing countries, leading to an increase in morbidities and mortalities from cardiovascular diseases, most of which are related to high blood pressure (14-15).

Many studies have been conducted in Iran on different aspects of hypertension, assessing its prevalence and associated risk factors but most of these studies are small- or intermediate-scale and are limited to specific counties or areas. There are only five large-scale surveys with nationally representative sample populations carried out during 1991 to 2011. All these studies were cross-sectional and did not evaluate the whole hypertension variation trend through a long period of time.

From a demographic point of view, time can be looked upon through three different temporal dimensions including age, period and cohort. Regarding hypertension which is being evaluated in this survey, age effects refer to the changes in blood pressure over one's lifetime. Period effects reflect changes in technological, socio-cultural, economic and environmental factors that can affect an entire population simultaneously at a specific time, but the effects might not be equal on everyone. For example a war may cause inflation which affects those with lower incomes to a greater extent. On the other hand, birth cohort effects refer to the changes in blood pressures of individuals who have experienced similar personal histories due to a common birth year. The problem with these three trends is that they are entangled due to a perfect collinearity (16), i.e. the natural mathematical relation amongst them:

Period=Age+Cohort

As a result of this identification problem with linear APC model it is impossible to observe independent variation in these trends and hence linear regression techniques fail to segregate them. For example if a trend in prevalence of hypertension is observed this could be due to the aging process (age effect), everyone exercising more and having a healthier diet (period effect) or nutritional advice given to mothers which can lead to healthier babies being born (cohort effect). Many techniques have been proposed to deal with this identification problem, of which we have used the intrinsic estimator (IE) method. This methodology is a new approach of estimation that is the unique estimable function of both the linear and nonlinear components of the APC model developed by the Moore-Penrose generalized inverse. IE

model conceives of age and period as confounders of the cohort effect (17-18). However, the conceptual details of the IE are sufficiently abstract and difficult to understand (18).
So to evaluate the effect of the existing measures against hypertension and to give health policy makers a better perspective of the trend of changes in hypertension to help them make national plans for prevention and treatment of hypertension, we conducted this study to assess the age, period and birth cohort effects by applying an entropy-based approach to APC model on hypertension. A statistical analysis was performed on data gathered through 5 surveys carried out from 1991 to 2011 in Iran, assessing the prevalence of hypertension among 24 to 69 year old adults.

Materials and Methods

- *Study design and setting*

The present study is designed on the basis of data gathered through five national health surveys (1990-91, 1999, 2003, 2007 and 2011) in Iran to analyze the effect of age, period, and birth cohort on hypertension among Iranian population aged 25 to 60 years. Following is a brief explanation on data collection of all the five surveys involved in this study. More details about the first four surveys carried out during 1991-2008 are presented by Hosseini et al in their study (19). The surveys were approved by local Ethics Committee. Informed consent was obtained from participants in all five surveys.

- *Data*

National health surveys 1990-91 and 1999

Blood pressures of 14884 and 20397 subjects aged 25-64 were measured in the first two Iranian national health surveys, the first, during June 1990 until March 1992 and the second, during April 1999 to February of 2000. The undersecretary of research, Ministry of Health and Medical Education, with collaboration from universities of medical sciences and blood transfusion organization carried out the sampling over the country provinces with a fraction of 1/1000 from the total metropolitan and rural population through a random cluster sampling of households comprising people aged 2-69 years. The data on blood pressure of the subjects aged 24-69 were used from these two surveys. BPs were measured only once in surveys of 1990 and 1999. So, the intraclass correlation (ICC) for assessment of reliability of blood pressure measurements was not applicable. The mentioned surveys were designed based on standard guidelines. Therefore, we believe that the method of BP measurement was valid and reliable.

National surveillance of risk factors for non communicable diseases, 2003 and 2007

The third and the fourth nationwide surveys used in this study were the first two rounds of National Surveillance of Risk Factors of Non-Communicable Diseases performed in 2003 and 2007 on 8900 and 30000 individuals aged 15-64, respectively. Of the 8900 subjects involved in the first round, blood pressure of 7710 Iranian citizens aged 25-64 years was measured and they were included in our study. From the second round 23511 people met the criteria and were included in this survey. Step by step instructions of WHO (6) was the basis on which these two surveys were designed upon with collaboration of 40 medical schools from all over the country. ICC of systolic and diastolic blood pressure measurements for the 2003 survey were 0.963 (0.961 - 0.965) and 0.948 (0.946 - 0.950), respectively. These values were 0.964 (0.963 - 0.966) and 0.935 (0.934 - 0.936) for the 2007 survey, respectively.

National surveillance of risk factors of non communicable diseases 2011

Our fifth data source was the Sixth national Surveillance of Risk Factors of Non-Communicable Disease (SuRFNCD) conducted in 2011 in which a multistage sampling framework was used with counties (or a combination of small adjacent counties) as primary sampling units, cities or villages as the secondary sampling units (SSU), households as sampling listing unit and dwellers aged between 6 to 70 years as the sampling elementary units. Using a KISH randomization method maximum of two persons were allocated in each household, one <55 and the other ≥55 years old in order to constitute our sample of 7653 Iranian adults. ICC of systolic and diastolic blood pressure measurements were 0.965 (0.964 - 0.966) and 0.923 (0.920 - 0.926), respectively.

Blood pressure measurements

In all surveys blood pressures were measured twice with an interval of at least one minute and analyses were performed on the mean of the two recordings in order to decrease the measurement bias. After at least a 5 minute rest, blood pressure was measured by a standard mercury sphygmomanometer with the subject in a wakeful state, sitting in a comfortable position and the right arm positioned at the heart level. A cuff with a bladder width of approximately 40% of the arm length and long enough to cover 80%–100% of the arm circumference was chosen and placed 1 inch above the antecubital fossa. The bladder was inflated to 30mmHg higher than the pressure needed to occlude the wrist pulse and then with the stethoscope placed over the brachial artery, the cuff was deflated. The first Korotkoff (K1) sound was considered as the set point for the systolic BP and the fifth phase of Korotkoff sounds as the diastolic BP.

- ***Statistical analysis***

Special attention has long been paid to Age-period-cohort (APC) models in statistical studies of human populations. The intrinsic estimator (IE) method, applying the principal component regression analysis of the APC analysis method, was developed by Yang (20-21). This study investigated the APC effect on the hypertension in Iranian adults using the IE model. In addition, this study analyzed the effect by gender. STATA software version 11.0 (Stata Corp., College Station, TX, USA) was used for the analysis using the “apc_ie” command statement. As in the APC analysis periods with five years apart were needed, the hypertension rate for years 1995 and 2005 were estimated by regression analysis.

Results

From the five surveys (1990 to 2011), 74155 subjects aged 25 to 69 years old were selected as the total sample size in this study. Table 1 shows the number of included subjects regarding their genders. The maximum and minimum participation rates were from the 2007 and 2011 surveys respectively.

The mean prevalence of hypertension by period year and gender is demonstrated in Table 2. Subjects in the first birth cohort were born in 1930-1934, and the last birth cohort included subjects born in 1985-1989. Thus, the analyses included 12 five-year birth cohorts (Table 2). Subjects in four of the 5-year cohorts, born between 1950 and 1969, were followed throughout the entire 20-year period. Table 3 presents the prevalence of HTN according to birth cohort and gender.

The age, period and cohort-based variation of prevalence of hypertension

- **Age effects**

Table 2 and figure 1-A show the variation in prevalence of hypertension for each survey by the age of the subjects. As illustrated the prevalence of hypertension increased with age for females. The male data showed a similar trend except for the 2003 and 2011 periods. For the 2003 period, the observed drop for 55 to 60 years of age was 3.5% while in the 2011was 8.1% for ages 50 to 60 years.
Tables 4, 5 and Figure 2-A demonstrate the coefficient of estimation of age effect on prevalence of hypertension which showed an almost monotonic increase trend with age. For males, the coefficient increased by 0.032 from age group 25 to 30, and the highest increase in slope was related to ages 40-45 and 45-50 years (the average of 0.061 increased in the coefficients for each 5 year age groups). For females, the coefficient increased by 0.038 from age group 25 to 30, and the most drastic increase in slope was related to ages 40-45 and 45-50 years. The average of the coefficients for each 5 year age groups was 0.066.

- **Period effects**

The variation in prevalence of hypertension for different age groups from 1990 to 2011 is shown in table 2 and figure 1-B. As figure 1-B depicts, the prevalence of hypertension was almost constant in all age groups for both genders from 1990-1999. However, the prevalence in other periods and for all age groups fluctuated differently. The estimation of period effects on prevalence of hypertension is presented in table 4, 5 and Figure 2-B. The coefficient increased significantly by 0.025 and 0.029 for males and females, respectively during 1990-1995 but the difference for both genders in other periods was not significant.

- **Birth cohort effects**

Figure 1-C depicts the prevalence of hypertension by birth cohorts to make an intuitive assessment of the birth cohort effects. The corresponding data are presented in Table 3. As the figure 1-C demonstrates the cohort-based prevalence of hypertension shows a declining trend in all studied periods for females except for the 2011 survey in birth cohort of 1950-1955 which remains almost unchanged. Although the general trend of prevalence for males also follows a decreasing trend, in periods of 2003, 2007, and 2011, birth cohorts of 1945-1949, 1975-1980, and 1950-1960 increase by 3.5%, 1.9%, and 8.1%, respectively.
The cohort effect on prevalence of hypertension is illustrated in tables 4, 5 and figure 2-C. For females, the coefficient of estimation of birth cohort effect on prevalence of hypertension which showed a monotonic decreases. As for the males, two rises are observed at 1930-1934 to 1940-1944 and 1945-1949 to 1950-1954 cohorts by 0.045, and 0.004, respectively.

Discussion

The findings of this study showed that the prevalence of hypertension increased with age. The age effect on the prevalence of HTN shows an almost monotonic increase trend. In addition the period effect increased the total prevalence of hypertension from 1992 to 1997. Assessing the cohort effect for females, adjusted for age and period, resulted a monotonic decreases in HTN prevalence from old to new cohort. As for the males two rises of birth cohort effect were observed at 1930-1934 to 1940-1944 and 1945-1949 to 1950-1954.
Although there are some studies assessing the effect of one or two aspects of the three age, period and cohort effects on blood pressure levels (not prevalence of hypertension), but to our knowledge this is the first study evaluating all the components of APC model on the prevalence of hypertension at the same time.

In one of these surveys Ananth et al. found a significantly higher incidence of preeclampsia in mother born in more recent cohorts. They proposed the high prevalence of smoking among women during 1970s as the reason for this observation (22). In another study, Ulmer et al. showed that the means of SBP and DBP have been decreasing especially in the recent cohorts (23). Their results are somehow similar to our findings which showed a declining trend in the prevalence of hypertension among both genders except for the birth cohort of 1930-1934 and 1954-1949. These results are supportive of the hypothesis proposed over the last few years claiming that an individual's lifestyle in their first years of life can significantly affect the patterns of blood pressure in their adulthood (24-25). This birth cohorts are coinciding with the period of World War II and the consequent baby boomers after war. In these years Iranian population suffered from great famine occurred in Iran. Low-quality diet during this period may influence the higher prevalence of HTN.

Other than nutrition, war affects the socio-economic status of a population to a great extent. Low socio-economic status has been proven to be correlated with incidence of hypertension in previous studies (26). These assessments show that the prevalence of chronic diseases' risk factors such as smoking are higher among low socio-economic classes and psychosocial factors such as unemployment and low income might be related to incidence of hypertension, problems that frequently surface during wars. Nevertheless the attitudes of surveys towards the role of socioeconomic factors in incidence of hypertension and cardiovascular diseases vary. Some, suggest the high prevalence of hypertension's main risk factors in low socioeconomic classes as the cause and so do not consider an important role for these factors (27). Therefore, caution must be exercised when commenting on this matter.

The war not only increased the psychosocial stresses in our community and changed people's lifestyles, but also had massive destructive effects on the health care programs and services especially in the ravaged areas. Since cohort effect is well known to be representative of the environmental factors and lifestyle during pregnancy and the first years of life (18, 21), the mentioned changes caused by the war might be the reason for the high prevalence of hypertension among the subjects born during that time.

Tu et al. also reached the same results regarding the cohort effect on the mean of blood pressure. They also found a reverse relationship between period and blood pressure showing that the level of blood pressure among subjects studied in the 60's was lower than the subjects of the 50's (28). The authors thought of the increase in consumption of fruits and vegetables and generally improvement in lifestyle as the main reasons for this birth cohort- and period-based decline observed in the blood pressure.

Our results revealed a rise in the prevalence of hypertension during 1992-1997 and it peaked in 1997, while it was steady during other periods, equal to the prevalence of the 1992. These observations might be due to the changes in the diet during 1985 to 1995. In this period consumption of dairy products, fruits and vegetables showed a significant decrease while an increase was observed in the consumption of different types of oil and sugar. Furthermore, obesity has also increased among Iranians during this 10 year period (29).

Reduced physical activity can be pointed out as another cause of the recently observed rise in prevalence of hypertension in Iranian population. The long term effects of limited physical activity are proposed as risk factors for hypertension (30). Accordingly the significant decrease in physical activity of Iranian population in recent years might influence the prevalence of hypertension. However it should be kept in mind that reduced physical activity, unhealthy diet and obesity are interconnected factors. In most available literature, a significant correlation has been reported between lack of exercise, unhealthy diet and high prevalence of obesity (31-32). Therefore, epidemiological transition in Iranian population has led to an increase in prevalence of hypertension among adult population which can explain the effect of cohort on hypertension.

The effect of age on blood pressure has been exclusively evaluated by many studies and it has been proven that blood pressure levels and subsequently the prevalence of hypertension increase by age (9, 33). The problem with these studies is that their results are not adjusted for period and birth cohort. Adjusted for both these factors, our study showed the same results (Figure 2-A). One of the probable mechanisms for the mentioned increase in blood pressure might be the decrease in the compliance of the arteries that progresses by aging. Other factors may include endothelial dysfunction, inflammation, cellular apoptosis, increase in the concentration of active metabolites, shortening of telomeres and epigenetic factors (34).

The findings of the present study regarding the effect of age on incidence of hypertension were congruent with the results of the survey conducted by Ananth et al. (22). The APC analysis they preformed was indicative of a strong influence imposed by age on incidence of preeclampsia in pregnant women in a way that the older subjects were approximately 6.7 times more at risk of preeclampsia.

Although APC analyses have been recently utilized on many different subjects, in some cases the true meaning of these three factors are not clear. Accordingly, a study has suggested that authors evaluating the effects of age, period and cohort, must provide additional explanations to clarify these concepts (21). Thus to explain further, cohort effect reflects the effects of environmental factors such as war, famine, inflation, recession, etc. that can affect the subject in their first years of life. On the other hand the period effect refers to the impacts of environmental and sociological changes on the later years of an individual's life. These changes include lifestyle alterations such as smoking, addiction, diet changes during adolescence and adulthood, etc.

Special attention must be paid to the fact that age, period and cohort effects not only are entangled from a mathematical and statistical point of view, but they are also interconnected in a conceptual and biological sense, so assessing each of these components individually seems illogical. This is why adjusting for the other two factors in order to evaluate one of them is of utmost importance. In this study analyses were performed in which all the three components were included. Another favorable point of the present study is using a similar sphygmomanometer in all the 5 surveys to measure blood pressures. This can strengthen the results of the study by decreasing the measurement bias to a great extent. However, the single measurement of BP in 1990 and 1999 surveys was the most important limitation of the present study so that we were unable to calculate ICC for assessment of reliability of blood pressure measurements for these studies. However, the mentioned surveys were designed based on standard guidelines which guaranteed the validity and reliability of their BP measurements.

Conclusion

The findings of this study showed that the prevalence of hypertension increased with age. The age effect on the prevalence of HTN shows an almost monotonic increase trend. In addition the period effect increased the total prevalence of hypertension from 1992 to 1997. Assessing the cohort effect for females, adjusted for age and period, resulted a monotonic decreases in HTN prevalence from old to new cohort. As for the males two rises of birth cohort effect were observed at 1930-1934 to 1940-1944 and 1945-1949 to 1950-1954.

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Figures legend:

Figure 1: variation in prevalence of hypertension for each survey by the age of the subjects, period, and birth cohort.

Figure 2: coefficient of estimation of age effect, period effect, and birth cohort effect on prevalence of hypertension.

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Table 1: Sample sizes by sex and study year

Study year	Men	Women	Total	Percentage
1990	6468	8416	14884	20.1
1999	9002	11395	20397	27.5
2003	3652	4058	7710	20.4
2007	11850	11661	23511	31.7
2011	3104	4549	7653	10.3
Total	34076	40079	74155	100.0

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Table 2: Prevalence (%) of hypertension by age, period year and sex

Age & sex	Period				
	1990	1999	2003	2007	2011
Men					
27	14	18.4	11	13.3	9.5
32	17.9	21.9	16.7	11.2	13.1
37	20.9	24.6	18.8	15.3	15.2
42	24.5	31.9	24.2	21.4	17.3
47	34.1	35.8	31.9	29.6	31.9
52	42.8	43.8	41.4	35.1	43.9
57	43.6	51.9	50	43.6	39.9
62	47.2	53.7	46.5	51.5	35.8
Women					
27	10.1	12.1	10.3	5.8	7.4
32	14	17.5	14	12.4	11.9
37	18.1	22.9	18.7	17.5	18.6
42	27.4	35.8	23.5	23.5	25.8
47	36	45	32.8	35.9	31.5
52	46.8	55.1	42.8	42.2	36.8
57	52.4	62.3	48.6	48	44.3
62	62.7	68.1	60.5	57.4	45

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Table 3: Prevalence (%) of hypertension by birth cohort, period year and sex

Birth Cohort	Period				
	1990	**1999**	**2003**	**2007**	**2011**
Men					
1930 - 1934	47.2				
1935 - 1939	43.6	53.7			
1940 - 1944	42.8	51.9	46.5		
1945 - 1949	34.1	43.8	50	51.5	
1950 - 1954	24.5	35.8	41.4	43.6	35.8
1955 - 1959	20.9	31.9	31.9	35.1	39.9
1960 - 1964	17.9	24.6	24.2	29.6	43.9
1965 - 1969	14	21.9	18.8	21.4	31.9
1970 - 1974		18.4	16.7	15.3	17.3
1975 - 1979			11	11.2	15.2
1980 - 1984				13.3	13.1
1985 - 1989					9.5
Total	**30.6**	**35.3**	**30.1**	**27.6**	**25.8**
Women					
1930 - 1934	62.7				
1935 - 1939	52.4	68.1			
1940 - 1944	46.8	62.3	60.5		
1945 - 1949	36	55.1	48.6	57.4	
1950 - 1954	27.4	45	42.8	48	45
1955 - 1959	18.1	35.8	32.8	42.2	44.3
1960 - 1964	14	22.9	23.5	35.9	36.8
1965 - 1969	10.1	17.5	18.7	23.5	31.5
1970 - 1974		12.1	14	17.5	25.8
1975 - 1979			10.3	12.4	18.6
1980 - 1984				5.8	11.9
1985 - 1989					7.4
Total	**33.4**	**39.9**	**31.4**	**30.3**	**27.6**

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Table 4: Intrinsic Estimates for the hypertension rate of Iranian male adult

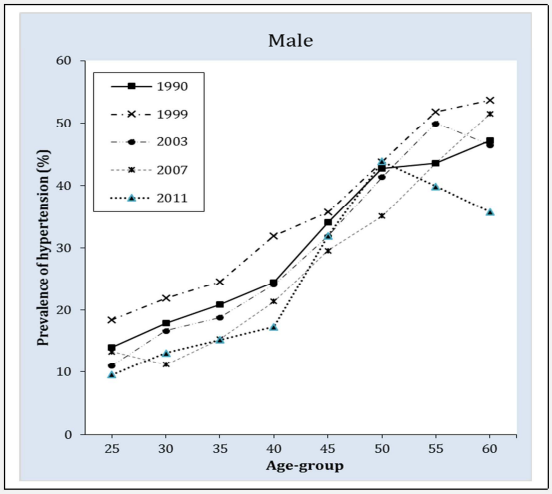
		Coefficient	Standard error	95% Confidence interval	
Age	27	-0.1439	0.0097	-0.163	-0.1248
	32	-0.1119	0.0089	-0.1294	-0.0944
	37	-0.0847	0.0092	-0.1028	-0.0667
	42	-0.0456	0.0093	-0.0639	-0.0272
	47	0.0153	0.0094	-0.003	0.0337
	52	0.0763	0.0093	0.0581	0.0946
	57	0.1261	0.009	0.1084	0.1438
	62	0.1684	0.0094	0.15	0.1867
Period	1990	-0.0202	0.0066	-0.0332	-0.0072
	1995	0.0047	0.0069	-0.0089	0.0182
	2000	0.0023	0.0069	-0.0112	0.0159
	2005	0.0112	0.0067	-0.002	0.0244
	2010	0.002	0.0071	-0.012	0.016
Cohort	1930-1934	0.0247	0.0184	-0.0114	0.0608
	1935-1939	0.0606	0.0139	0.0333	0.0878
	1940-1944	0.0693	0.0122	0.0455	0.0931
	1945-1949	0.0289	0.0111	0.0071	0.0506
	1950-1954	0.0333	0.0101	0.0135	0.0530
	1955-1959	0.0176	0.0105	-0.0029	0.0381
	1960-1964	0.0002	0.0103	-0.0200	0.0205
	1965-1969	-0.0162	0.0097	-0.0352	0.0028
	1970-1974	-0.0373	0.0104	-0.0577	-0.0170
	1975-1979	-0.0431	0.0112	-0.0652	-0.0211
	1980-1984	-0.0608	0.0130	-0.0862	-0.0354
	1985-1989	-0.0770	0.0223	-0.1208	-0.0332
Constant		0.2991	0.0042	0.2909	0.3074

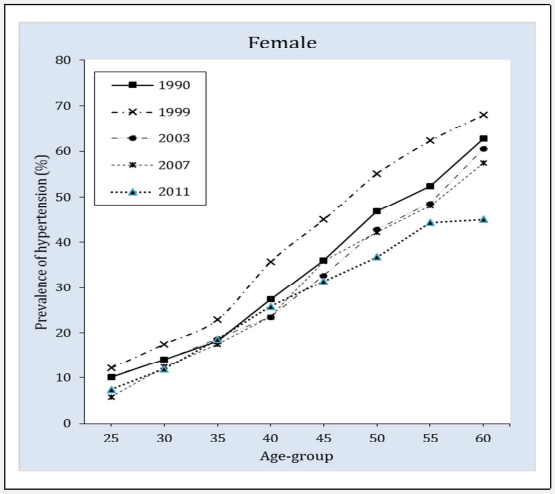
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Table 5: Intrinsic Estimates for the hypertension rate of Iranian female adult

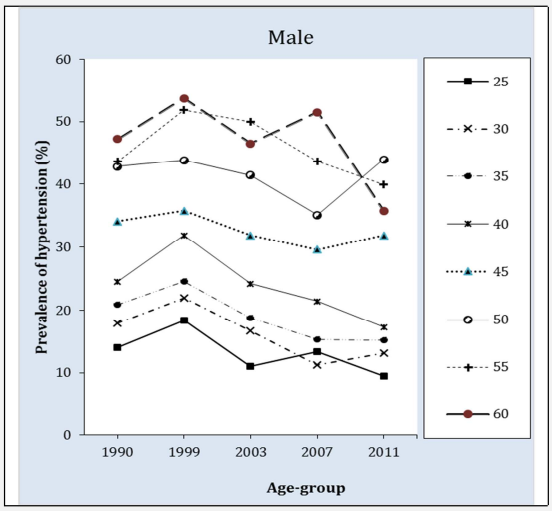
		Coefficient	Standard error	95% Confidence interval	
Age	27	-0.1785	0.0085	-0.1952	-0.1617
	32	-0.1408	0.0078	-0.1561	-0.1254
	37	-0.0976	0.0081	-0.1135	-0.0817
	42	-0.0415	0.0082	-0.0576	-0.0255
	47	0.0211	0.0082	0.0051	0.0372
	52	0.0904	0.0082	0.0744	0.1064
	57	0.1413	0.0079	0.1257	0.1568
	62	0.2055	0.0082	0.1894	0.2216
Period	1990	-0.0187	0.0058	-0.0301	-0.0073
	1995	0.0099	0.006	-0.002	0.0217
	2000	0.0068	0.0061	-0.005	0.0187
	2005	0.0033	0.0059	-0.0083	0.0148
	2010	-0.0013	0.0063	-0.0136	0.011
Cohort	1930-1934	0.1104	0.0162	0.0787	0.1420
	1935-1939	0.0563	0.0122	0.0324	0.0802
	1940-1944	0.0421	0.0107	0.0212	0.0630
	1945-1949	0.0310	0.0097	0.0120	0.0501
	1950-1954	0.0045	0.0088	-0.0128	0.0218
	1955-1959	-0.0074	0.0092	-0.0254	0.0106
	1960-1964	-0.0199	0.0091	-0.0377	-0.0022
	1965-1969	-0.0308	0.0085	-0.0474	-0.0142
	1970-1974	-0.0364	0.0091	-0.0542	-0.0186
	1975-1979	-0.0440	0.0099	-0.0633	-0.0246
	1980-1984	-0.0495	0.0114	-0.0718	-0.0273
	1985-1989	-0.0562	0.0196	-0.0946	-0.0178
Constant		0.3298	0.0037	0.3226	0.3370

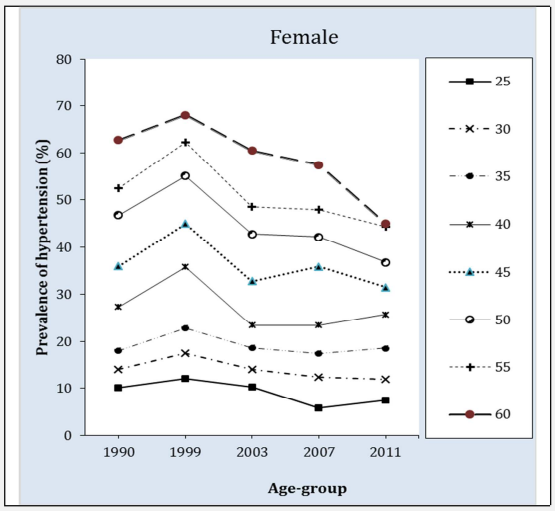
A


Male
Prevalence of hypertension (%)
Age-group
1990
1999
2003
2007
2011

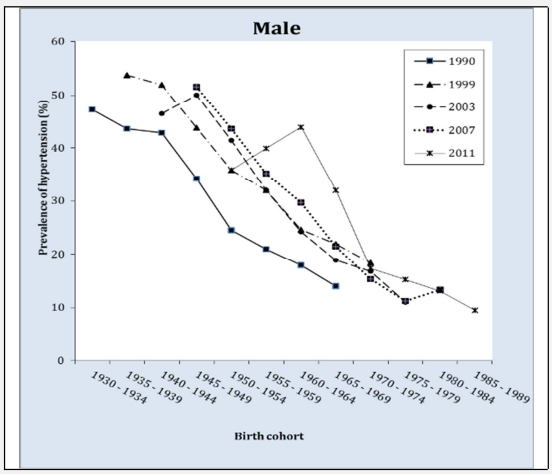

Female
Prevalence of hypertension (%)
Age-group
1990
1999
2003
2007
2011

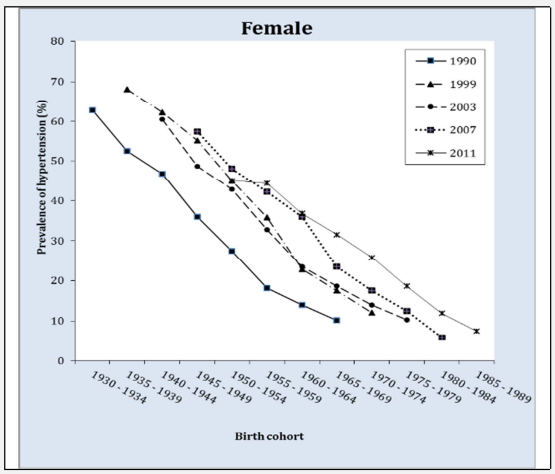
B


Male
Prevalence of hypertension (%)
Age-group
25
30
35
40
45
50
55
60


Female
Prevalence of hypertension (%)
Age-group
25
30
35
40
45
50
55
60

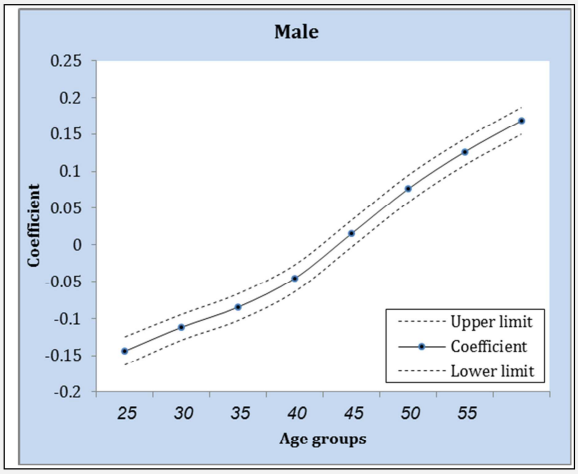
C

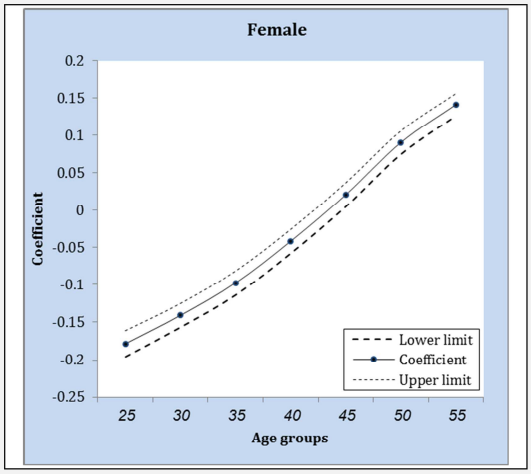

Male
Prevalence of hypertension (%)
Birth cohort
1990
1999
2003
2007
2011


Female
Prevalence of hypertension (%)
Birth cohort
1990
1999
2003
2007
2011

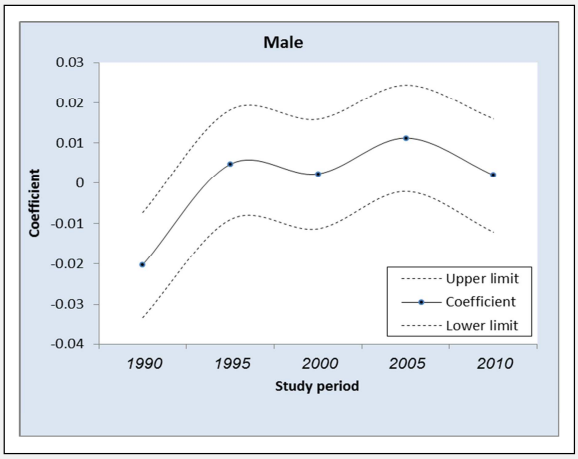
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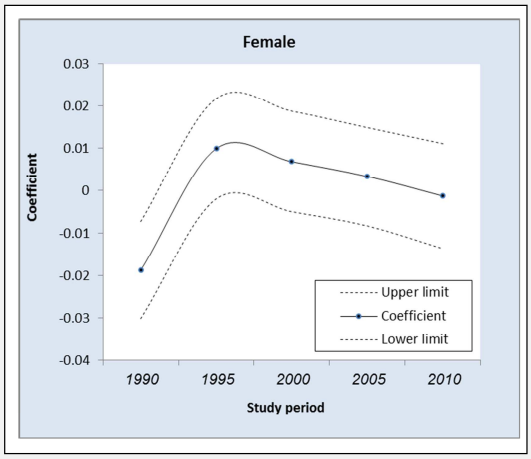
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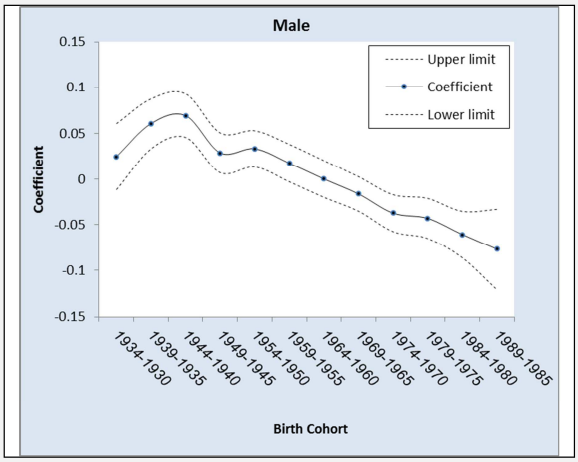


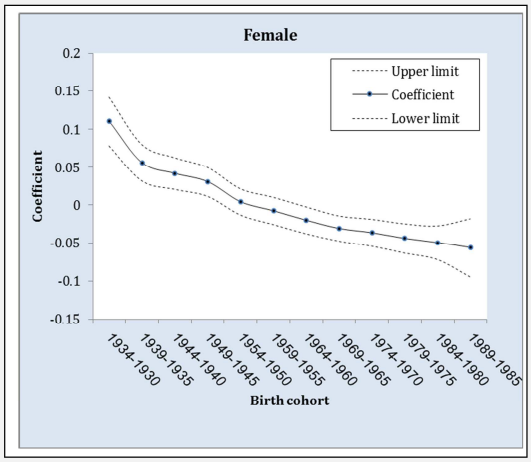
B





C





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Highlights

- Hypertension is a well-known health problem all over the world.
- We assessed the age, period and birth cohort effects on prevalence of hypertension.
- Age effect on the prevalence of HTN showed an almost monotonic increasing trend.
- Period effect increased the total prevalence of hypertension from 1992 to 1997.
- Cohort effect also showed a monotonic decrease in HTN prevalence.

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