International Scholars Journals

International Journal of Public Health and Epidemiology ISSN: 2326-7291 Vol. 6 (6), pp. 373-382, June, 2017. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Race-and sex-related differences in the incidence of coronary heart disease in the First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study

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Accepted 09 May, 2017

Despite the many cardiovascular studies conducted in the United States (US), nationally representative estimates of incidence of coronary heart disease (CHD) have been lacking. This study aimed at investigating incidence estimates of CHD in a nationally representative sample of the US population and to compare race- and sex-related incidence estimates. We used data from the First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study (NHEFS) [n = 6,346]. We determined cumulative incidence and incidence density and used log-rank and chi-square test for estimates comparison. A total of 382 CHD events occurred among 6,346 study participants from 1971 to 1992. The cumulative incidence was 9.93% in the NHEFS cohort; 13.46% among men and 7.00% among women (*P*< .001); 9.72% among Whites and 11.01% among non-Whites (*P* = .64). The incidence density, per 1,000 person-years, was 3.68 in the NHEFS cohort; 4.99 among men and 2.66 among women (*P*< .001); 3.65 among Whites and 3.90 among non-Whites (*P* = .67). From 1971 to 1992 in the US, the cumulative incidence of CHD was 9.93% and the incidence density was 3.68 per 1,000 person-years. While CHD incidence did not vary across race, males had a higher incidence than females.

Keywords: Cumulative incidence, incidence density, coronary heart disease, sex-related differences, race-related differences, Kaplan Meier, National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study.

INTRODUCTION

Coronary heart disease (CHD) is classified among the most common cardiovascular diseases in the United States [US] (Labarthe, 2011; Roger et al., 2012; Go et al., 2014; Centers for Disease Control and Prevention [CDC], 2016a).This condition is characterized by its clinical and pathological variability comprising a broad array of cardiac illnesses among them, “acute myocardial infarction, acute ischemic heart disease, angina pectoris, atherosclerotic cardiovascular disease, and all other forms of chronic ischemic coronary heart disease” (Go et al., 2014 p.*e*290). CHD affects both males and females (Khamis et al., 2016). It is one of the leading causes of mortality worldwide and is projected to become the main cause of mortality globally by 2020 (Finegold et al., 2013; Antman and Loscalzo, 2015; Sanchis-Gomar et al., 2016). Over the past 40 years, mortality due to CHD has been declining in the US (Roger et al., 2012; Harris, 2013; Moran et al., 2014; Wilmot et al., 2015). From more than 500 deaths per 100,000 in 1980, rates have decreased to less than 200 per 100,000 in 2010 (Ford et

al., 2014). Nonetheless, the US remains one of the high-income countries with the highest CHD mortality rates (Nowbar et al., 2014). More than 25% of all deaths in the US are due CHD (CDC, 2016a). Recent data released by the American Heart Association show that about 15.5 million adults older than 20 years of age have been diagnosed with CHD in the US (Sanchis-Gomar et al., 2016). On average, 525,000 new diagnoses and 155,000 silent cases of CHD occur in the US every year (Mozaffarian et al., 2016).

From an epidemiologic standpoint, incidence is a statistic known as an important measure of a disease in a population or community. Generically, incidence expresses the proportion of newly occurring events among an exposed population during a period of time (Szklo and Javier, 2007; CDC, 2012; Sanchis-Gomar et al., 2016). It is referred to as cumulative incidence or incidence proportion (Philippe, 2000; Labarthe, 2011; CDC, 2012). Incidence can also be calculated as incidence density or incidence rate and it represents the number of events per person-time of the population at risk (CDC, 2012; Pierre, 2016). In longitudinal studies, cumulative incidence is calculated by use of the life table of the actuarial type or the Kaplan Meier method of survival analysis. In the latter case, incidence estimates are deducted as the reverse of the survival probabilities (Szklo and Javier, 2007). With regards to the incidence density, time can be determined either as "the sum of the time at risk for each participant in the study or the product of the average size of the population and the duration of the study" and it is usually expressed in person-years [py] (CDC, 2012; Pierre, 2016 p. 35). In addition to quantifying the amount of risk for a condition, the contribution of incidence measurement to public health includes the identification of risk factors and high-risk populations for future interventions (Ford et al., 2014).

Since the late 1950s, many epidemiologic studies about CHD have been conducted with the aim "to identify factors that could explain differences in rates of CHD between populations or in risks of coronary events among individual members of a particular population" (Labarthe, 2011 p. 62). However, data about CHD incidence have been scarce and most of the time, incidence estimates are not based on nationally representative samples (Ford et al., 2014; Mozaffarian et al., 2016; Yahagi et al., 2015). Besides the health care system, many sources of incidence estimates of CHD in the US are based on homogeneous race- or sex-related cohort studies (Ford et al., 2014; Wong, 2014). Therefore, the objectives of the present study were to estimate the incidence of CHD in the US population and to compare the estimates across race and sex using the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (NHEFS), a nationally representative longitudinal health study of the US population. We hypothesized that during the period of the study, the incidence of CHD varied across race and sex.

MATERIALS AND METHODS

Data Source

Design and data collection

We used data from the NHEFS. The aim of the NHEFS is to evaluate the relationship between clinical, nutritional, and behavioral factors assessed from the first National Health and Nutrition Examination Survey (NHANES-I), and "morbidity, mortality, and hospital utilization, as well as changes in risk factors, functional limitation, and institutionalization" (Cox et al., 1997; CDC, 2016b p.1). The NHEFS is a prospective cohort study that spans between 1971 and 1992 (Cox et al., 1992). The baseline population for this study consisted of NHANES-I participants between 25 and 74 at the time of enrollment (Cox et al., 1997). In addition to the data collected from NHANES-I, the NHEFS also includes data from a series of four follow-up evaluations collected from 1982 to 1984 and in 1986, 1987, and in 1992 (Cox et al., 1992). The data collection process of NHEFS has been described elsewhere (Cox et al., 1997; Cox et al., 1992; CDC, 2016c).

Population of study: inclusion criteria

We included in our study data from the 1982-1984, 1987, and 1992 NHEFS follow-up evaluations. An assessment was also conducted in 1986 but those data were only collected on participants between 55 and 74 years-old at baseline (Cox et al., 1997) and thus were not included in this study. Study participants were included who satisfied the following additional criteria: 1) Be between the ages of 25 and 74 at the time of enrollment in NHANES-I; 2) Have had no history of CHD at the time of enrollment; 3) Have been surveyed about smoking habits and cholesterol level at baseline and throughout the entire study; and 4) Have not been lost to follow-up at the last evaluation. The third criterion was included because data were not collected about the smoking habits and cholesterol level among all participants enrolled at baseline and this study included both as risk factors. We performed our analysis on a final sample of 6,346 participants.

The Variables

CHD event

We defined a CHD event as the first episode of the disease that was diagnosed by a health care facility or a death due to a first CHD episode that was confirmed by a death certificate.

Time variable

Time to event was measured as the time from the date of the NHANES-I enrollment interview to the time of a CHD

event or censoring whichever came first. The date of the CHD event was either the date of the first admission to a health care facility with a diagnosis of CHD or the date of death from a first episode of CHD on a death certificate.

Socio-demographic variables

We considered age both as a continuous variable expressed in years and as a binary variable with two levels: '25 to 49' for participants between 25 and 49 and '50 to 74' for those between 50 and 74 years old. Race at baseline in NHANES-I was categorized as 'White', 'Negro', and 'other' (CDC, 2015a). In our study, we expressed race as a two-level categorical variable: 'White', for participants who identified as White at the time of enrollment and 'non-White', for all other participants. We reported sex as a binary variable, 'males' and 'females'. Education was categorized to reflect whether or not the participant had achieved a graduate level degree. Income was expressed as a binary variable based on whether or not study participants had a household income above or below $25,000. When taking into account the effect of inflation (i.e., cumulative rate approximately of 363% in 2016), a value of $25,000.00 in 1975 would be approximately $116,000.00 in 2016 (United States Department of Labor, 2016; Mc Mahon, 2016).

Medical history variables

In this study, we used the body mass index (BMI) as an indicator of overweightness and adiposity. We calculated BMI from baseline height and weight measurements using a standard equation: BMI = (weight in pounds / height in inches^2) × 703 (CDC, 2015b).BMI was further categorized into four standard levels: underweight (BMI < 18.5); normal weight (BMI between 18.5 and 24.9); overweight (BMI between 25.0 and 29.9); and obese (BMI ≥ 30.0) [CDC, 2015b]. In order to assess the influence of diabetes and hypertension on CHD, we created binary variables in a 'yes/no' format as reported by the participants and based on the question "have you ever been told by a doctor you have the condition?"(CDC, 2016d p.44). We framed cholesterol both as a continuous variable expressed in mg/dL and as a binary variable. We used the cutoff point of 240 mg/dL to denote whether the participant had normal or low cholesterol (less than 240mg/dL) and whether they had high cholesterol (240 mg/dL and above).

Behavioral variables

Smoking, alcohol use, and physical activity were included as 'yes/no' variables based on whether or not study participants smoked, drank alcohol, or were engaged in physical activity at the time of initial evaluation.

Statistical Analysis

Description of the participants

We described the characteristics of the participants across levels of BMI using frequencies and corresponding percentages for categorical variables or means and corresponding standard deviations (SD) for continuous variables. We used the chi-square test or analysis of variance (ANOVA) where appropriate to compare the characteristics of the study participants across BMI levels.

Incidence

In the present study, we calculated incidence both as cumulative incidence and incidence density. Cumulative incidence represents the probability of an event during a study period while the incidence rate can be conceptualized as the speed at which an event will happen among participants' of a study (Pierre, 2016). We used the Kaplan Meier procedure to compute the cumulative incidence, which we considered as the reverse of the survival probabilities. We determined the incidence density by dividing the total number of CHD events by the total follow-up time during the duration of the study expressed in py. We calculated incidence estimates for the NHEFS cohort, across race, sex, and other characteristics of the study population. Where appropriate, we compared these incidence estimates across segments of the study population using the log-rank test and the chi-square test. Analyses were computed using SAS 9.4 (Cary, NC) with the exception of the incidence density estimates (Microsoft Excel). All incidence estimates were unadjusted and significance level was fixed at $\alpha = 0.05$.

RESULTS

Characteristics of the Study Population

Demographic and socioeconomic characteristics

Of the study participants, 3.42% were found to be underweight, 46.52% were classified as being of normal weight, 34.10% were overweight, and 15.96% were categorized as obese (Table 1). On average, study participants were 48 years old at the time of enrollment and most of them (54.63%) were females. Approximately 87% of the study respondents were White. Most of the participants (93.82%) had at most a college education. The majority of the study respondents (93.80%) had a family income of less than $25,000.00.

Medical history and behavioral characteristics

A history of diabetes was found among 4.18% of the study participants and hypertension was reported in 11.05% of them. Regarding personal behavior, smoking was recorded among 37.09% of the study population. A

Table 1. Baseline Characteristics of the Participants of the First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study with a CHD Event, United States, 1971-1992.

		Standard Levels of Body Mass Index, % or Mean (SD)				
Characteristics	**Total, % or Mean (SD)**	**Underweight**	**Normal Weight**	**Overweight**	**Obese**	***P*[a]**
			Demographic and socio-economic			
Total participants (%)	6346	217 (3.42)	2952 (46.52)	2164 (34.10)	1013 (15.96)	
Age, years	48.11 (14.05)	46.94 (15.32)	46.08 (14.19)	49.71 (13.57)	50.87 (13.46)	<.001
Age group						<.001
25 to 49	3347 (52.74)	119 (3.55)	1745 (52.14)	1049 (31.34)	434 (12.97)	
50 to 74	2999 (47.26)	98 (3.27)	1207 (40.25)	1115 (37.18)	579 (19.30)	
Sex						<.001
Male	2879 (45.37)	68 (2.36)	1211 (42.06)	1224 (42.51)	376 (13.06)	
Female	3467 (54.63)	149 (4.30)	1741 (50.22)	940 (27.11)	637 (18.37)	
Race						<.001
White	5505 (86.75)	181 (3.29)	2647 (48.08)	1873 (34.02)	804 (14.60)	
Non-White	841 (13.25)	36 (4.28)	305 (36.27)	291 (34.60)	209 (24.85)	
Education level						<.001
College or less	6315 (93.82)	215 (3.40)	2939 (46.54)	2155 (34.13)	1006 (15.93)	
Graduate level	390 (6.18)	7 (1.79)	226 (57.95)	127 (32.56)	30 (7.69)	
Family income						<.001
< $25,000.00[b]	5714 (93.80)	203 (3.55)	2607 (45.62)	1962 (34.34)	942 (16.49)	
>$25,000.00	378 (6.20)	7 (1.85)	214 (56.61)	128 (33.86)	29 (7.67)	
Region						.01
Non-Southern	4716 (74.31)	143 (3.03)	2201 (46.67)	1630 (34.56)	742 (15.73)	
Southern	1630 (25.69)	74 (4.54)	751 (46.07)	534 (32.76)	271 (16.63)	
			Medical history			
Diabetes						<.001
Yes	265 (4.18)	7 (2.64)	78 (29.43)	108 (40.75)	72 (27.17)	
No	6081 (95.82)	210 (3.45)	2874 (47.26)	2056 (33.81)	941 (15.47)	
Hypertension						<.001
Yes	701 (11.05)	22 (3.14)	230 (32.81)	247 (35.24)	202 (28.82)	
No	5645 (88.95)	195 (3.45)	2722 (48.22)	1917 (33.96)	811 (14.37)	
Stroke						.04
Yes	86 (1.36)	7 (8.14)	33 (38.37)	28 (32.56)	18 (20.93)	
No	6260 (98.64)	210 (3.35)	2919 (46.63)	2136 (34.12)	995 (15.89)	
			Behavioral			
Smoking						<.001
Yes	2354 (37.09)	127 (5.40)	1209 (51.36)	735 (31.22)	283 (12.02)	
No	3992 (62.91)	90 (2.25)	1743 (43.66)	1429 (35.80)	730 (18.29)	
Alcohol						<.001
Yes	4745 (74.77)	147 (3.10)	2318 (48.85)	1595 (33.61)	685 (14.44)	
No	1601 (25.23)	70 (4.37)	634 (39.60)	569 (35.54)	328 (20.49)	
Physical activity					<.001	
Yes	5714 (90.04)	192 (3.36)	2681 (46.92)	1963 (34.35)	878 (15.37)	
No	632 (9.96)	25 (3.96)	271 (42.88)	201 (31.80)	135 (21.36)	
High cholesterol					<.001	
Yes	1992 (31.39)	31 (1.56)	754 (37.85)	793 (39.81)	414 (20.78)	
No	4354 (68.61)	186 (4.27)	2198 (50.48)	1371 (31.49)	599 (13.76)	
Cholesterol, mg/dL	221.99 (46.5)	204.13 (38.1)	215.13 (45.8)	228.03 (45.8)	232.83 (47.7)	<.001

SD = Standard deviation.
CHD = Coronary heart disease.
[a]P = p-value obtained from chi-square test or ANOVA.
[b]Considering inflation (i.e. cumulative rate approximately of 363% from 1975 to 2016), $25,000.00 in 1975 would approximately correspond to $116,000.00 in 2016.

history of alcohol consumption was found among 74.77% of the participants and, most of them,(90.04%) reported involvement in some kind of physical activity. Participants of the study had an average serum cholesterol level of 221.99 mg/dL.Thirty-one percent had a high blood cholesterol level.

Table 2. Survival Rates and Corresponding Cumulative Incidence of CHD Events by Use of the Kaplan Meier Method in the First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study, United States, 1971-1992.

Characteristics	Survival rates (%)	CI (%)	*P*[a]
Socio-demographic			
General population	90.07	9.93	
BMI level			
Underweight	92.43	7.57	<.001
Normal weight	92.57	7.43	
Overweight	89.89	10.11	
Obese	82.78	17.22	
Obesity Status			
Yes	82.78	17.22	<.001
No	91.43	8.57	
Age group			
25 to 49	95.78	4.22	<.001
50 to 74	81.68	18.32	
Sex			
Male	86.54	13.46	<.001
Female	93.00	7.00	
Race			
White	90.28	9.72	.642
Non-White	88.99	11.01	
Education level			
College or less	88.83	11.17	.001
Graduate	93.7	6.3	
Family income [b]			
< $25,000.00	89.88	10.12	.044
> $25,000.00	92.23	7.77	
Region			
Southern	88.24	11.76	.002
Non-Southern	90.94	9.06	
Medical history			
Diabetes Status			
Yes	74.84	25.16	<.001
No	90.64	9.36	
Hypertension			
Yes	89.74	10.26	<.001
No	90.48	9.52	
Stroke Status			
Yes	73.72	26.28	.001
No	90.21	9.79	
Behavioral			
Smoking status			
Yes	89.99	10.01	.186
No	89.97	10.03	
Alcohol			
Yes	91.29	8.71	<.001
No	86.32	13.68	
Physical activity			
Yes	90.47	9.53	.003
No	86.18	13.82	

Incidence of CHD

Cumulative incidence

We estimated a cumulative incidence of CHD of 9.93% for the whole study population (Table 2). Seventeen percent of obese participants had CHD, compared to 7.57% of underweight participants, 7.43% of normal weight participants, and 10.11% of overweight participants. The differences in the cumulative incidence of CHD across BMI categories was statistically significant ($P < .001$). Male participants had a significantly higher

Tabe 2. Continued.

High cholesterol			
Yes	86.46	13.54	<.001
No	91.62	8.38	

CI = cumulative incidence.
CHD = Coronary heart disease.
[a]P-value obtained from log-rank test.
[b]Considering inflation (i.e. cumulative rate approximately of 363% from 1975 to 2016), $25,000.00 in 1975 would approximately correspond to $116,000.00 in 2016.

Table 3. Incidence Rate of CHD Events per 1,000 Person-Years among the Participants of First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study, United States, 1971-1992.

Characteristics	CHD event	Time, years	ID	*P*[a]
Socio-demographic				
General population	382	103675	3.68	
BMI level				0
Underweight	13	3158	4.12	
Normal weight	124	49125	2.52	
Overweight	143	35548	4.02	
Obese	102	15844	6.44	
Obesity Status				0
No	280	87831	3.19	
Yes	102	15844	6.44	
Age group				0
25 to 49	78	59218	1.32	
50 to 74	304	44457	6.84	
Sex				0
Male	227	45447	4.99	
Female	155	58228	2.66	
Race				0.67
White	332	90860	3.65	
Non-White	50	12815	3.90	
Region				0.00
Northeast	94	24324	3.86	
Midwest	89	26050	3.42	
West	77	27218	2.83	
South	122	26083	4.68	
Region				0.00
Non-Southern	260	77592	3.35	
Southern	122	26083	4.68	
Education level				0.00
College or less	312	75905	4.11	
Graduate	70	27770	2.52	
Family income[b]				0.04
< $25,000	368	97254	3.78	
>$25,000	14	6421	2.18	
Medical history				
Diabetes status				0.00
No	343	100060	3.43	
Yes	39	3615	10.79	
Hypertension				0.00
No	323	93087	3.47	
Yes	59	10588	5.57	

incidence of CHD (*P* < .001). Cumulative incidence was higher among the study population that was 50 years and older (18.32%) compared to those under 50 years (4.22% *P*< .001). There was no significant difference in the

Table 3. Continued.

Stroke				0.00
No	372	102707	3.62	
Yes	10	968	10.33	
Smoking status				0.23
No	232	66049	3.51	
Yes	150	37626	3.99	
Alcohol				0.00
No	141	25324	5.57	
Yes	241	78351	3.08	
Behavioral				
Physical activity				0.00
No	50	9363	5.34	
Yes	332	94312	3.52	
High cholesterol				0.00
No	196	72423	2.71	
Yes	186	31252	5.95	

ID = incidence density in number of events per 1,000 person-years.
CHD = Coronary heart disease.
[a]P-value obtained from chi-square test.
[b]Considering inflation (i.e. cumulative rate approximately of 363% from 1975 to 2016), $25,000.00 in 1975 would approximately correspond to $116,000.00 in 2016.

incidence between white (9.72%) and non-white (11.01%) study participants (*P* = .64). Across all the other study population characteristics but smoking, we observed significant difference in the cumulative incidence (*P* < .05).

Incidence density

The incidence rate of CHD in the NHEFS cohort was 3.68 per 1,000 py (Table 3). Male participants had a higher rate of 4.99 per 1,000 py than female participants who had a rate of 2.66 per 1,000 py (*P*< .001). Variability was observed in the incidence rates across BMI levels. As expressed in 1,000 py, the highest rate, 6.44 was seen among obese participants. This group was followed by the underweight category with a rate of 4.12, then by the overweight, and the normal weight groups displaying an incidence rate of 4.02 and 2.52 respectively (*P* < .001). With regards to race, no difference was seen in the incidence rates between the white segment of the study population and its non-white counterpart (*P* = .67). No difference was seen in the incidence rates based on smoking status (*P* = .23). The older segment of the study population had higher rate of CHD, 6.84 per 1,000 py than the younger segment of the population, 1.32 per 1,000py (*P*< .001). As we observed for cumulative incidence, all medical history and behavioral characteristics except smoking carried along significant differences in incidence density rates.

DISCUSSION

The purpose of our study was to provide incidence estimates of CHD in the US using a longitudinal health cohort study of the US population and to compare estimates across race and sex. Many studies of cardiovascular disease conducted in the US since the 1950s reported a decrease in incidence rates of CHD particularly in high-income countries (Mozaffarian et al., 2016; Sanchis-Gomar et al., 2016). Most of the time, incidence of CHD is reported as the incidence of acute myocardial infarction [AMI] (Moran et al., 2014; Mozaffarian et al., 2016). Globally, from 1990 to 2010, the incidence of AMI, per 100,000 population, decreased from 222.7 to 195.3 cases among men and from 136.3 to 115.0 cases among women. Significant decline in incidence rates was recorded in Australasia, Western and Central Europe, and North America (Moran et al., 2014). In the US, incidence rates of AMI varied based on the study or dataset used. Data from the Worcester Heart Attack Study revealed a decrease in incidence rate of AMI from 277 per 100,000 py in 1975 to 209 per 100,000 py in 2005. More recently, data from Kaiser Permanente Northern California based on AMI hospitalization objectified a decrease in the incidence rate of AMI from 274 in 1999 to 208 in 2008 per 100,000 py (Mozaffarian et al., 2016). Estimates from the Atherosclerotic Risk in Community Study investigating a sample of participants aged 35 to 84 years for the period 2005-2011 revealed an average AMI incidence rate per 100,000 population of 370 for white men, 590 for black men, 210 for white women, and 400 for black women (Mozaffarian et al., 2016).

In our analysis, the incidence of CHD varied significantly across BMI categories with the obese segment of the population having the highest rate. Both incidence density and cumulative incidence of CHD displayed a J-shape relationship across BMI levels confirming the trends for highest CHD incidence rates associated with

the highest BMI values. That distribution has not been consistent in many CHD-related longitudinal studies. While Canoy and his colleagues (2013) found a J-shape relationship between CHD mortality and the standard categories of BMI in a cohort of women aged between 55 and 74 in England and Scotland, a 10-year cohort study of men aged between 40 and 79 of China displayed a U-shape distribution of CHD mortality across BMI levels (Chen et al., 2006). The latter two studies were conducted considering CHD mortality as the event of interest while in our study the definition of CHD was broader and included both fatal and non-fatal CHD. Furthermore, a separate analysis conducted by Canoy and his colleagues of the association between non-fatal CHD incident cases and BMI found a linear relationship, findings that have been confirmed by Pierre (2016). Many investigators also found variable relationships between BMI and fatal and non-fatal CHD incidence (Rosengren et al., 1999; Logue et al., 2011; Hotchkiss et al., 2013).

Men in the present study had a higher incidence of CHD than women. Those findings of higher incidence among men have been consistent in the literature since the Framingham Heart Study began in early 1950s (Lawton, 2011; Wong, 2014; Dawber et al., 2015; Yahagi et al. 2015; Sanchis-Gomar et al.,2016). Although the difference tends to decrease with age, higher rates of risk factors such as smoking, cholesterol level, and high blood pressure are at least partially responsible of the higher incidence in men (Jousilahti et al., 1999). With regards to race however, we found no difference in the incidence of CHD between white and non-white populations. This finding did not align with other reported racial differences in rates of CHD mortality (Weintraub and Vaccarino, 2003). Reasons for racial variability in CHD mortality include differences in access to care and to the type of interventions conducted on individuals affected by a CHD event (Hotchkiss et al., 2013). Individuals in a community or population might be exposed to the same health risks but exposure to different treatment procedures is a known source a variation in health outcomes (Cooper et al., 2000).

In this study, the incidence of CHD in the US population varied with age. Data from the Atherosclerotic Risk in Communities Study revealed an increase in fatal and non-fatal CHD events starting at age 35 through age 84 (Wong, 2014). The influence of age on CHD reduces the protective advantage of being a woman on CHD compared to a man (Wong, 2014). We did not find a change in the incidence of CHD across smoking status, a finding that was in sharp contrast with existing implication of smoking as a determinant of CHD across smoking status (Aronow, 1973; Jousilahti et al., 1999; American Heart Association [AHA], 2017). This finding might be explained by the fact that smoking interacted with the relationship between other risk factors and CHD (CDC, 2010; Merrill, 2010).

Public Health Implications

The determination of the incidence of CHD in the NHEFS cohort during the period 1971-1992 allowed us to have an assessment of the importance of that condition during that period not only in the NHEFS cohort but also across many segments of the study population, mainly sex and race. In addition to playing an important role in the determination of the causal association, (Szklo and Javier, 2007) incidence also "(1) is a key measure in helping to define the burden of a disease and identify high-risk populations, (2) provides valuable information in helping decision makers set public health priorities, and (3) is a relevant measure to assess the collective influence of risk factors in a population" (Ford et al., 2014 p. 1).

Limitations

We attempted to compare our incidence estimates to those available in the literature (Mozaffarian et al., 2016). However, most of those assessments did not come from nationally representative study populations. In addition, many of the studies from which those estimates were calculated used a restricted definition of CHD event often limited to either AMI occurrence or mortality (Mozaffarian et al., 2016) while our definition of CHD included both CHD occurrence and mortality over the whole clinical and pathological spectrum of the disease. Thus, higher rates obtained from our analysis might be due to our more inclusive definition of CHD.

CONCLUSION

From 1971 to 1992, a total of 382 CHD events occurred in a sample of 6,346 participants. After an average of 16 years of follow-up, the cumulative incidence of CHD was estimated to be 9.93% and CHD events occurred at a rate of 368 per 100,000 py. The incidence estimates did not vary across race but males had higher rates than females**.** The decrease in trends of CHD incidence reported over the past decades are encouraging aspects indicating that emphasis should be kept on prevention in order to maintain the downward trends in the same direction although the exact starting declining period still needs to be elucidated. The findings from our study suggest that more investigations using nationally representative datasets are needed to provide updated estimates of incidence and to continue to explore differences in estimates across segments of the population particularly race and sex.

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