Original Article

Equivalence of Cholesterol Levels at Hospital-based Health-Check Program with Population-based Studies: A Comparative Study

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ABSTRACT

Background: High cholesterol is an important coronary risk factor. Only limited population-based studies have reported prevalence of hypercholesterolemia in India. Hospital-based data on cholesterol levels are available but have not been used to determine population-wide prevalence.

Objective: To determine equivalence of hospital-based cholesterol levels with population-based levels for identification of hypercholesterolemia.

Methods: Successive individuals undergoing measurements of total cholesterol levels at a tertiary-care hospital-based preventive health checkup program (primary and secondary prevention) were recruited. We compared total cholesterol levels in this group with two population-based studies – Jaipur Heart Watch (JHW) conducted in Jaipur and India Heart Watch (IHW) in 11 cities in India. Age-specific and age-adjusted levels and prevalence of hypercholesterolemia in the three groups were compared. Descriptive statistics are reported.

Results: We evaluated 45,534 subjects from hospital-based health checkup program, 1941 in JHW and 6123 in IHW. Age-adjusted mean levels of cholesterol in the three studies, respectively, were in men 170.6±46, 188.5±38 and 178.4±39 mg/dL (p<0.001), and in women 186.4±43, 182.2±36 and 184.6±39 mg/dL (p=n.s.). In hospital-based studies the levels were significantly lower among men in age groups >40 years and women >50 years, while no difference was observed in younger age-groups. Age-adjusted prevalence (%) of hypercholesterolemia ≥200 mg/dL in the three groups, respectively, were in men 28.1, 28.9 and 25.1 and in women 27.8, 25.6 and 24.9 (p<0.05). Hypercholesterolemia ≥240 mg/dL was in men 7.5, 6.8 and 6.2 and in women 7.8, 6.1 and 5.4 (p<0.01).

Conclusions: Cholesterol levels and hypercholesterolemia prevalence in hospital-based subjects are significantly different from population-based studies, especially in older subjects. (J Clin Prev Cardiol 2013;2(1):1-7)

Introduction

Lipid abnormalities, especially high total cholesterol and high low density lipoprotein (LDL) cholesterol, are the most important coronary heart disease (CHD) risk factors. Prospective epidemiological studies in high- and middle-income countries in Europe and North America have reported a consistent, direct and continuous association of total and LDL cholesterol with CHD events, morbidity and mortality (1,2). Similar results have been reported in prospective studies from Australasia and East Asia (3). No similar studies exist in India (4). The INTERHEART case-control study reported significant association of abnormal lipids (apolipoprotein-apo B/apo A, total cholesterol and low HDL cholesterol) with incident acute myocardial infarction in South Asians (Indians) (5).

There have been multiple studies to identify population-wide mean levels of total cholesterol and its lipoproteins and triglycerides and to identify prevalence of various dyslipidemias in high- and middle-income countries (6). The Global Burden of Chronic Diseases Risk Factor study reported levels of total cholesterol and determined trends in 180 countries over a 35-year period from 1980 (7). It was observed that total cholesterol levels were high in high- and middle-income countries in the 1980s and declined significantly in both high- and middle-income countries. In lower middle and low-income countries there was paucity of population-based data in 1980s and the total cholesterol levels were low. There was no change in cholesterol levels in low-income countries such as India over the 35-year period (7).

Large population based studies to determine mean population cholesterol levels and prevalence of hypercholesterolemia are very few in India (6). Previous studies in India have been limited to local (a city) or regional (a particular state) levels and reported hypercholesterolemia prevalence of 18–36% (Table 1) (8–15). These studies include single-site studies such as in Delhi, Jaipur and Chennai (8–10). Multisite studies are Indian Industrial Population Surveillance Study (11) among industrial populations and India Migration Study (12) in rural areas. The Indian Council of Medical Research (ICMR) Integrated Disease Surveillance

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Table 1.
Prevalence (%) of hypercholesterolemia in recent studies in India

Study (Year)	Year reported	Sample size	High cholesterol ≥200 mg/dL	
			Men	**Women**
Delhi Urban Slum Study(8)	2001	532	26.8	27.5
Jaipur Heart Watch-2 (9)	2002	1,123	34.1	36.1
Chennai Urban Population Study (10)	2003	1,262	25.7	--
Indian Industrial Population Surveillance Study (11)	2007	10,442	25.1	--
India Migration Study: Rural (12)	2010	1,983	21.1	27.8
Integrated Disease Surveillance Project: Urban (13)	2010	15,223	31.7	32.8
Integrated Disease Surveillance Project: Rural (13)	2010	13,517	19.5	26.4
Integrated Disease Surveillance Project: Periurban or Urban Slum (13)	2010	15,751	18.1	23.4
Indian Women's Health Study: Urban (14)	2011	2,008	-	27.7
Indian Women's Health Study: Rural (14)	2011	2,616	-	13.5
Jaipur Heart Watch Studies (15)	2012	1,941	28.9	25.6
India Heart Watch Study (16)	2013	6,123	25.1	24.9

Project (13) and Indian Women's Health Study (14) reported prevalence of hypercholesterolemia at selected urban and rural sites in the country. Collated data from JHW studies are also available (15). IHW study reported prevalence of hypercholesterolemia in 11 cities in various regions of the country (16). Sample size in these studies varied from less than a thousand to 15,000 and although some of these studies (e.g., ICMR study) are large, they are not large enough to be nationally representative. On the other hand, large amount of data on cholesterol and other lipoprotein lipids are available at diagnostic centers and hospitals across India. These data are not population based, supposedly biased and vitiated by concomitant use of cholesterol-lowering drugs in many subjects. There has been no comparative study in India to evaluate the equivalence of these hospital- or clinic-based lipid levels with population-based cholesterol levels. We performed a comparative study to determine equivalence of mean levels of total cholesterol and prevalence of hypercholesterolemia obtained at a routine health-check at a tertiary care hospital in Rajasthan, India, with those obtained at population-based surveys. The surveys were JHW studies (15) in the Jaipur urban middle class populations and in the IHW, a multisite population based study in urban middle class subjects in India (16). If the results of the three datasets are similar, systematically collected data from various national laboratories can be used to derive national values and also to identify trends in prevalence of hypercholesterolemia.

Methods

Three studies were performed. The first study was an audit of reports of consecutively performed total cholesterol levels during a preventive health-check program (primary and secondary prevention) and routine tests at a tertiary care hospital in Rajasthan. The second dataset have been obtained from second to fifth JHW studies, serial cross-sectional studies in urban middle class subjects in Jaipur (15). The third study, the IHW, is a nationwide multisite study to identify prevalence of cardiovascular risk factors in urban middle class populations of India (17,18). The first protocol was approved by the hospital management committee who permitted use of anonymized routinely collected data in patients attending the hospital for preventive health-checks. The second and third study protocols were approved by the institutional ethics committee at Monilek Hospital and Research Centre, Jaipur and Fortis Escorts Hospital, Jaipur, India, respectively. Informed consent was obtained from all participants.

Preventive Health-check Program

To foster a culture of disease prevention a health checkup program was initiated at Fortis Escorts Hospital, Jaipur, a tertiary care multi-specialty hospital. Various forms of preventive health-checks are available (general, cardiac and advanced) for men and women. The major components of the health-checks are physical examination, blood hemogram, liver and kidney function tests, glycemic status, chest radiography, abdomen ultrasonography, stress test, echocardiography and others. A fasting lipid profile is performed in all the health-check packages. We collated all the lipid profile data from July 2007 to December 2012. The subjects included men and women enrolling for routine check-up (primary prevention) or those with established cardiovascular disease (secondary prevention). In the present study, results of total cholesterol levels and prevalence of borderline hypercholesterolemia (total cholesterol ≥200 mg/dL) as well as moderate hypercholesterolemia (≥240 mg/dL) are presented. Total cholesterol measurement is least amenable to fluctuations and is the most standardized and is comparable across studies; therefore, we used this parameter only. Serum total cholesterol was estimated using cholesterol oxidase-peroxidase (CHOD-POD) method in all the studies. Internal as well as external validation protocols are regularly performed and the coefficient of variation is less than 5%, as per the National Accreditation Board for Laboratories (NABL), India requirements. Details of gender and age were available for all the subjects while details of disease status or treatment status were not available.

Jaipur Heart Watch (JHW) studies

These are a series of cross-sectional epidemiological studies in urban populations of India performed over a 20-year period from 1991 to 2010 and reported earlier (15). The first two studies were general population based, while the latter three were confined to urban middle class locations in Jaipur. In brief, population-based men and women residing in middle class locations (based on municipal classification) of Jaipur were evaluated for various cardiovascular risk factors (smoking, tobacco use, physical activity, obesity, central obesity, hypertension, hypercholesterolemia, other dyslipidemias and diabetes). Changing trends in various risk factors have been reported (15). Total cholesterol levels showed increasing trends while prevalence of hypercholesterolemia >200 mg/dL did not show significant increase (15). For the present analysis we combined data obtained from the second JHW study to fifth JHW study performed from the years 2000–2010. We used data for men and women aged 20–59 years residing in middle class locations. Detailed methodology of cholesterol measurements has been reported earlier (19).

India Heart Watch (IHW)

This is a population-based study in 6123 subjects (response 62%, men 3388, women 2735) in 11 cities in different regions of India (18–18). The cities, in alphabetical order, were Ahmadabad, Belgaum, Bikaner, Chandigarh, Dibrugarh, Jaipur, Jammu, Lucknow, Madurai, Nagpur and Patna. Uniform methodology was used for data collection and biochemical investigations. Prevalence of multiple cardiovascular risk factors (smoking, non-smoked tobacco use, diet, physical inactivity, hypertension, lipid abnormalities, diabetes and others) was determined. Prevalence of various dyslipidemias (high cholesterol, cholesterol lipoproteins – HDL, LDL and non-HDL cholesterol, and triglycerides) – has been reported earlier (16). In the present study we report mean total cholesterol levels and prevalence of hypercholesterolemia.

Statistical Analyses

All the data in different studies were computerized. SPSS software package was used for analyses (SPSS Inc., Chicago, USA). Descriptive statistics are reported. Age-adjustment was performed by direct method with standard Jaipur population for hospital-based data and JHW and India standard population for IHW. Intergroup comparisons in various age groups were performed using unpaired t-test for numerical variables and X^2 test for categorical variables. *P* value <0.05 were considered significant.

Results

In the hospital-based health check-up and screening program, details of serum cholesterol levels were available in 45,534 subjects (men 33,528, women 12,007). In population-based studies, we evaluated 1941 subjects (men 1029, women 912) in JHW studies (15) and 6123 subjects (men 3388, women 2735) in IHW study (16). Details of these population-based studies are reported elsewhere (15,16).

Mean levels of total cholesterol in hospital-based, JHW and IHW studies in men and women in different age groups is shown in Table 2. Age-adjusted total cholesterol levels in hospital-based, JHW and IHW studies, respectively, were in men 170.6±46, 188.5±38 and 178.4±39 mg/dL (p<0.001) and in women 186.4±38, 186.2±36 and 184.6±39 mg/dL (p=n.s.). Cholesterol levels were significantly lower in men in hospital-based subjects as compared to the two population-based studies (p<0.001). In women there was no significant difference in hospital-based subjects versus population-based studies. Age-specific data reveal that the mean cholesterol levels were significantly lower among men in age groups 40–49, 50–59, 60–69 and ≥70 years, while in younger age-groups the levels in hospital-based subjects were similar to the population based studies. In women cholesterol levels were significantly lower in age groups 50–59, 60–69 and ≥70 years and similar in others (Table 2).

Prevalence of hypercholesterolemia was determined according to two criteria: (i) borderline and high cholesterol ≥200 mg/dL and (ii) high cholesterol ≥240 mg/dL. Age-specific and age-adjusted prevalence in the three studies are shown in Table 3. In men the prevalence of borderline and high cholesterol in hospital-based subjects (28.1%) was similar to the population-based JHW (28.9%, p=n.s.) and greater than IHW (25.1%, p<0.01). The prevalence was similar in hospital-based women (27.8%) as compared to the JHW (25.6%, p=n.s.) and significantly greater than IHW (24.9%, p<0.01). Prevalence of hypercholesterolemia (≥240 mg/dL) was also greater in hospital-based men (7.5%) and women (7.8%) as compared to population-based JHW studies (6.8% and 6.1%) and IHW study (6.2% and 5.4%) (p<0.05).

Discussion

This study shows that mean total cholesterol levels obtained at a primary and secondary preventive health-check program at a tertiary care hospital are not equivalent to those obtained in population-based studies. Prevalence of hypercholesterolemia (borderline and high

Table 2.

Age-specific comparisons of mean total cholesterol levels in hospital-based subjects with population-based Jaipur Heart Watch (JHW) and India Heart Watch (IHW) studies

	Men						Women					
	Hospital-based		JHW Population based		IHW Population based		Hospital-based		JHW Population based		IHW Population based	
Age-group	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
<30	1584	174.0±41	229	175.9±34	253	163.7±40***	459	167.7±42	181	174.0±28	204	160.5±31*
30–39	4750	187.4±43	225	190.8±36	570	177.3±38***	1670	178.5±35	231	183.2±35*	565	174.3±33*
40–49	8298	180.9±45	316	192.4±44***	899	184.0±36*	3182	189.3±41	259	186.5±35	777	185.7±36*
50–59	9680	166.5±47	259	192.9±34***	869	183.8±41***	3605	192.7±44	241	197.9±42	626	192.4±39
60–69	6429	157.5±44	--	--	532	178.6±42***	2232	183.3±46	--	--	443	197.5±43***
70+	2787	154.2±44	--	---	265	179.2±43***	859	177.7±49	--	--	122	199.3±43***
Age-adjusted	33528	170.6±46	1029	188.5±38***	3388	178.4±39***	12007	186.4±43	912	186.2±36	2735	184.6±39
Comparisons of hospital based subjects with JHW and IHW; unpaired t-test, *p<0.05, **p<0.01, ***p<0.001.												

Table 3.

Age-specific and age-adjusted prevalence of borderline and high and high total cholesterol levels in hospital-based and population-based JHW and IHW studies

	Men			Women		
Age-group	**Hospital-based**	**JHW Population based**	**IHW Population based**	**Hospital-based**	**JHW Population based**	**IHW Population based**
Cholesterol ≥200 mg/dL						
<30	23.9	19.9	18.6	17.9	14.8	9.8**
30–39	36.9	30.7*	23.8***	23.0	27.2	20.2
40–49	33.4	37.3	31.0	37.1	33.2	33.9
50–59	24.0	39.3***	32.9***	42.3	43.6	40.7
60–69	17.4	--	31.4***	36.8	--	46.0***
70+	15.4	--	27.5**	32.9	--	50.0***
Age-adjusted	28.1	28.9	25.1**	27.8	25.6	24.9***
Cholesterol ≥240 mg/dL						
<30	5.9	3.0*	4.0	5.9	2.2*	1.5*
30–39	10.7	8.3	6.7**	5.2	6.9	2.7*
40–49	8.7	11.1	6.9	9.6	6.2	5.8***
50–59	6.6	8.5	9.6**	13.2	16.2	10.9
60–69	4.2	--	6.6**	11.1	--	14.7*
70+	3.7	--	6.8**	9.3	--	16.4*
Age-adjusted	7.5	6.8	6.2**	7.8	6.1*	5.4***

Comparisons of hospital based subjects with JHW and IHW; X^2 test: *p<0.05, **p<0.01, ***p<0.001.

cholesterol or high cholesterol) is significantly greater in hospital-based subjects than population-based cohorts.

Mean levels of total cholesterol in all the three cohorts in the present study are higher than previous population-based studies from India (8–15). Prevalence of hypercholesterolemia is also significantly greater than studies conducted in rural and semiurban locations (Table 1). On the other hand prevalence of hypercholesterolemia is almost similar to studies performed in various urban locations, industrial populations and among the middle class populations (8–16). A recent study in Kerala (20) reported a high prevalence of borderline and high total cholesterol levels (men 51.4%, women 61.5%); this is much more than the present cohorts. These studies show variations in cholesterol levels in different populations and reflect importance of macrolevel and microlevel socioeconomic factors (21). These factors are the main drivers of population lipid levels as reported in many studies (17). This study shows that cholesterol levels are lower in men aged less than 40 years. The reason for this is conjectural and could be due to better lifestyle or greater awareness of dietary factors in this self-selected population (as reported in IHW) (17) or greater use of lipid-lowering drugs (statins) (22). We do not have any data on baseline disease status or drug intake in the hospital-based cohort in the present study and cannot comment on this presumption. This is a major study limitation. However, almost equal cholesterol levels in young individuals at a hospital-based health-check program with JHW and IHW population cohorts suggest that hospital-based data can be used as a marker of prevalence of hypercholesterolemia in the younger population. The present study, thus, shows that this is context specific; hospitals in urban areas reflect urban subjects and private tertiary care hospitals can be a guide to cholesterol levels in the Indian middle class.

Lipid registries, which routinely obtain and evaluate hospital- or clinic-based data on cholesterol and other lipoprotein lipids, are virtually nonexistent in most countries. However, registries for acute coronary syndromes, chronic stable coronary heart disease and diabetes exist and many of these registries have reported data on cholesterol and other lipids (23). International REACH registry (24) and US-based PINNACLE registry (25) have been conducted in high-income countries of Europe and North America and reported significant hypercholesterolemia in stable coronary artery disease patients. Swedish Diabetes Registry (26) reported blood lipids in 75,048 diabetic patients. Hypercholesterolemia, high LDL and low HDL cholesterol were more important than severe hypertriglyceridemia. Mean total cholesterol in 29,373 subjects not on statins was 182–187 mg/dL. These values are lower than the population-based levels reported in population studies from Sweden or other high-income countries (7). More population- or clinic-based prospective lipid registries are needed in India.

The Global Burden of Chronic disease Risk Factors' study used population-based data for determining population level secular trends in blood cholesterol levels in more than 180 countries of the world from the year 1980 to 2008 (7). Different levels of blood cholesterol were reported for high-income, middle-income and low-income countries (27). In 1980 the mean total cholesterol levels in high-, middle- and low-income countries, respectively, were 214, 187 and 169 mg/dL. These levels declined steeply in high and middle countries to 197 and 179 mg/dL while remained almost unchanged in low-income countries (27). The greatest decline occurred in western high-income countries and in eastern and central Europe (7). By contrast, cholesterol levels increased in east and southeast Asia and Pacific subregions. Increase in total cholesterol was observed in Japan, China and Thailand. In India, the population-level cholesterol data are limited, and no change was observed (7). On the other hand, review of population-based studies in India shows increase in prevalence of hypercholesterolemia in India in the last 40 years (28). The present study shows that data limitations in the Global Burden of Chronic Disease Risk Factors Study (7) can be overcome by collating data from diagnostic centers and hospital preventive health-check programs, especially in young subjects who are not on statins from population-specific centers.

Apart from the limitations discussed above, a major limitation of the present study is data confined to a single non-government tertiary care hospital. To overcome this limitation we compared the hospital data (with predominant middle- and upper-middle class focus) with population data using studies focused on middle-class populations in Jaipur and India. Studies from different types of hospitals and clinics – primary and secondary care centers in urban areas and from semi-urban and rural areas – are needed to identify nationwide prevalence of lipid abnormalities. Other limitations include lack of individual level data on status of health, associated cardiovascular risk factors, presence of established cardiovascular diseases and treatment status. However, as the study aim was to evaluate equivalence of hospital-based levels in a large cohort with population-based study, these limitations may not be relevant.

In conclusion, this study demonstrates that cholesterol values obtained in a hospital-based preventive program are not equivalent to population levels. However, there are certain subsets of subjects – younger men and women and identical socioeconomic status subjects – where these values are similar. Context-specific use of hospital-based lipid levels may be appropriate. Low prevalence of hypercholesterolemia in the present cohorts (with high cardiovascular risk) (18) suggests that alternative lipid measurements (apolipoproteins A and B, other cholesterol lipoproteins, triglycerides or lipid remnants) may be more important lipid abnormalities in the Indian population.

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