# Multivariate Analysis in an Epidemiological Study of Coronary Heart Disease in Slum Population of Mumbai 

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#### Abstract

Apart from widespread clinical impression of a rapid spurt in the proportion of cases with Coronary Heart Disease (CHD) being evaluated by various levels of medical practice there are demographic and social reasons to apprehend a major epidemic of CHD in India and other developing countries. The objective of present study was to study independent effect of multiple factors on occurrence of Coronary Heart Disease in the age group of 25 to 64 years in urban slum community in Mumbai using multiple regression and logistic regression in a case control model. The present study was designed to be a case - control study conducted in an urban slum, community with a population of 35,967 , served by Urban Health Centre, attached to the department of Preventive and Social Medicine of teaching institute. CHD was diagnosed using Rose Questionnaire and/or documentary evidence of MI. Total 186 cases ( 126 males and 60 females) of CHD was found. The equal number of control (186) were selected from the same community matching the two nonmodifiablerisk factors age \& sex in 1:1 proportion. At the end of P (IN) limit 0.05 the regression equation summarisedSystolic Blood Pressure, Cholesterol, Built, Type of Work, Family History of CHD, Diastolic Blood Pressure, Family Size,Smoking, Diabetes Mellitus and Tobacco Chewing as having independent significant association. In the logistic regressionstepwise forward entry method (WALD) including constant in the model, at the last step (considering the P limit of 0.05 asinclusion criteria) the classification table for study type shows Observed vs. Predicted correctness of $91.40 \%$ with variablesas Family History of CHD, Family History of Hypertension, Hypertension, Diabetes, Systolic BP $>160$, Diastolic BP $>104$,Cholesterol $>220$. The equation shows that with presence of two risk factors probability rises steeply and after the presenceof three factors there is no much scope to change.


Keywords: CHD, India, Epidemiology, Multivariate, NCD

## Introduction

Apart from widespread clinical impression of a rapid spurt in the proportion of cases with Coronary heart Disease (CHD) being evaluated by various levels of medical practice there are demographic and social reasons to apprehend a major epidemic of CHD in India and other developing countries. Coronary Heart Disease (CHD) has been defined as impairment of heart function due to inadequate blood flow to the heart compared to its needs caused by obstructive changes in the coronary circulation to the heart.[1] The cause of coronary Heart Disease (CHD) is multifactorial. The underlying morbid
process develops insidiously, and only late in its natural history does clinical illness supervenes. Sometimes sufferer has no warning of his condition and dies suddenly, of all events. Only rarely does the clinician have the opportunity to examine the patient before there has been major damage within cardiovascular system. To prevent such chronic disease, a new concept of Primordial Prevention is receiving special attention. This is a primary prevention in its purest sense, that is, prevention of emergence or development of risk factors in population in which they have not yet appeared. [2]

All over India, a major number of people live in urban slums and Mumbai, a metro city has a large share in it. Such large population always go ignored due to the misconception that coronary heart disease is a disease of affluence while there is a need to study the presence of risk factors for CHD among the slum population. The developed countries have utilized research findings on the modifiable risk factors for Coronary Heart Disease such as smoking, elevated blood cholesterol, sedentary life style and high blood pressure to produce a major impact on prevention of CHD. Apart from the use of mortality and morbidity statistics which has its own limitations the need of more direct evidence on causation directs the researcher to the population based study. It then becomes more imperative to study the independent causative effect of each of these multiple factors in causing Coronary Heart Disease (CHD) in such population groups.

After a statistically significant association between a risk factor and disease has been identified, an epidemiologist wishes to determine the magnitude or strength of the association to quantify the risk resulting from exposure. Measures of association utilize comparative risk statements to study why certain event occur. It defines the risk of developing a disease among individuals exposed to a risk factor compared with those who are not exposed to it. The relative risk (RR) compares the probability of an outcome among subjects who are exposed tospecific risk factor to the probability of that outcome among subjects who lack the exposure.

However the relative risk (RR) can bedirectly calculated in a cohort or experimental study. The odds ratio (OR) is another measure of comparative risk. It compares the odds that a disease will occur among the subjects who are exposed to a particular risk factor to odds that a disease will occur among subjects who lack the exposure.

In a case - control model for CHD where the subjects have been matched on the basis of one or more potentially confounding variable the formula will be -
$O R=\frac{\text { Odds that exposed subjects will have CHD }}{\text { Odds that non }- \text { exposed subjects have CHD }}$
While studying a disease like CHD which has multiple causative factors, multivariate analysis helps in determining the independent effect of risk factors and in creating model to assess the risk to the person depending on presence or absence of particular risk factor. Considering these facts an attempt has been made to study role of various factors influencing Coronary Heart Disease in an urban slum population.

## Aim \& Objectives

Aim
To study the epidemiology of Coronary Heart Disease in Urban Slum Population in Mumbai

## Objectives

1. To study independent effect of multiple factors associated with Coronary Heart Disease in the age group of 25-64 years using multiple regression and logistic regression.
2. To suggest recommendations on the basis of study findings.

## Methodology

The present study was conducted in two phases in an urban slum community with a population of 35,967 , served by Urban Health Centre, attached to the department of Preventive and Social Medicine of teaching institute. This community was established in 1977 as a resettlement colony, in the south east part of Mumbai. It is bound by Thane creek on its eastern border. It consists of a total 11 sectors of varying sizes, starting from ' $A$ ' sector up to ' $K$ '. The ' $F$ ' sector is the largest in size and the ' K ' sector is the smallest.Each sector consists of a varying number of lines of kuchha or pucca houses, with houses in each row facing the opposite row of houses thus forming a pair. Most of the houses have maximum area of $10 \times 15$ square feet, comprising of a single room, with a 'mori' at one corner. Few houses have an additional floor. There are 20 common toilets for each sector and 2 common water taps for each line. The community has migration from Tamil Nadu, Kerala, Andhra Pradesh, Bihar, Uttar Pradesh and Maharashtra. Since there are very few community based epidemiological studies of CHD in India, considering low prevalence rate of CHD and the need of large sample size [3], instead of taking the random sample, it
was decided to cover the whole community by using door to door survey method in the first phase. On the basis of evidence available in literature, study population was restricted to the age group of 25-64 years. CHD was diagnosed if one or both of the following criteria were satisfied:
(a) History of chest pain as assessed by the official English version of Rose Questionnaire[4] to diagnose angina after excluding any obvious cause of pain due to local factors.
(b) Myocardial Infarction (MI) based on complaint of typical severe chest pain. Documentary evidence of MI treated was insisted upon.

Effort was made to visit each and every authorised house, in serial order in each sector. A register was maintained in which number of persons in the age group of 25 to 64 years staying in the house was recorded age and sex wise. Those who had fulfilled the criteria for diagnosis of CHD were selected as cases. In the second phase of the study Age and Sex, the two non-modifiable risk factors, were controlled. For this purpose once a case was diagnosed the next first person in serial order of the same age and same sex was selected as control if found not suffering from CHD on the basis of above mentioned criteria. This way the first phase was the cross sectional while the second phase was the case control model. Being the most practical and economic tool, questionnaire method was used for data collection. A pre-structured, pretested proforma was prepared. The proforma was filled up for 186 cases of CHD detected in first phase and 186 controls studied in second phase as a part of case control study. Proforma elicited information relevant to the coronary heart disease including Age, Sex, Religion, Marital Status, Education, Duration of Stay, Address, Type of Family, Occupation, Income, Family history of CHD and its risk factors, History of hypertension and Diabetes Mellitus and treatment taken for it, Dietary habits, Smoking, Alcohol consumption, Tobacco chewing etc.

Details of some important variable are as follows: -
Age: Effort was made to find out the exact age in years using information available on Ration Card and asking relevant questions.

Socioeconomic Status: Being urban slum population per capita monthly income was used to determine socioeconomic class as suggested by Gupta M.C. et al [5]

Family History: Family history of CHD or its risk factor was considered positive only if it was present in either of either parents or brothers or sisters.

Physical Activity: Physical activity was defined as light, moderate and heavy consistent with criteria recommended by expert Committee of WHO.

Dietary Habits: Twenty four hour recall method was used to assess the dietary habits of subjects. Special care was taken to estimate quantities of food consumed. Subjects were helped to estimate amounts by use of household measures and standard measures.

Smoking: Those who had ever smoked cigarettes or bidis regularly for more than one year were labelled as smokers. Variation in number of cigarettes or bidis was taken in consideration by asking detail history and maximum number and period as well minimum number and period were recorded.

Alcohol Consumption: Those who have ever consumed alcohol regularly for more than one year were labelled as Alcohol consumers. Information about period and frequency of drinking alcohol was obtained.

Built: Ectomorph (linear, asthenic), Mesomorph (bony, muscular), and Endomorph (round, fat)

Hypertension: Blood pressure was recorded using standard guidelines.[4] Blood pressure recording in the sitting position was selected for analysis. Hypertension was defined as a systolic Blood Pressure of 160 mm of Hg or more and/or a diastolic blood pressure (Phase V) of more than 95 mm of Hg or history of hypertension with regular current consumption of antihypertensive drugs.

Obesity: Obesity was estimated by using Body Mass Index (BMI) as suggested by WHO Expert committee

Lab investigations done included Urine Sugar, Albumin and Microscopic examination, Haemoglobin, Fasting and Post Lunch Blood Sugar and Serum Cholesterol along with ECG and Fundoscopy.

The data was analysed on computer using SPSS package.

## Results \& Discussion

Out of 35,967 of total population of Cheeta Camp community $33.43 \%$ were in the age group of 25 to 64 years. Total numbers of 11,772 individuals in this age group were interviewed and 186 cases of Coronary Heart Disease (CHD) were registered. Equal numbers of controls were selected from the same population.

The prevalence of CHD in Cheeta Camp was 15.80 per thousand in the age group of 25 to 64 years. In males it was 20.82 per thousand and in females it was 10.48 per thousand. [7]Among 186 cases 126 (67.7\%) were males while 60 (32.3\%) were females. As the selection of controls was done by matching the age and sex in 1:1 proportion the age $\&$ sex distribution of the controls is exactly the same. [6]

Table 1: Distribution of multiple risk factors

| Factors / Variables in <br> Multiple Regression (n=372) | Mean | S.D. |
| :--- | :--- | :--- |
| Family Size | 5.696 | 1.575 |
| Family Income | 2281.452 | 909.129 |
| Per Capita Income | 430.320 | 258.856 |
| Working Hours | 9.113 | 1.560 |
| Body Mass Index | 22.204 | 3.825 |
| Systolic Blood Pressure | 144.608 | 24.026 |
| Diastolic Blood Pressure | 89.715 | 12.280 |
| Total Cholesterol | 226.629 | 47.482 |
| Total Caloric Intake | 2560.086 | 283.702 |
| Percentage of Fat Calories | 20.758 | 4.709 |

Table 1 show the mean and standard deviation of various factors used in multiple regression. The average family size was 5.95 among cases while it was 5.44 among controls. The family size has been found to be related with occurrence of CHD independently.

This could be rather attributable to the increase in stress but needs further evaluation. Study done by, Dandekar V. M. [8], and Mitra A. [9] showed that a large family is still looked upon as an asset by vast majority of households in the country. This is believed to be economically advantageous, as well supposed to act as a shock absorber in the stress factors. Does it apply even to the Urban Slum population of lower socioeconomic status and what is the exact cause of
relation between family size and CHD needs to studied further. Out of 186 cases 165 ( $88.7 \%$ ) were married while 21 ( $11.3 \%$ ) were single. The proportion of singles was more in comparison with controls (7, 3.8 \%). Marital status had no independent relation with occurrence of CHD. Padmavati et al [10] as well Chadda S. L. et al [11] had found CHD more prevalent in higher socio-economic group. In the present study the socioeconomic status was determined only of the selected 372 subjects using Per Capita Income criteria. There was no independent significant association. The high predominance of low socio-economic status in slum population is the limitation to draw a crystal clear conclusion.

Table 2: Summarization of Multiple Regression equation

| Variables selected stepwise at the end of $\mathbf{P}$ (IN) <br> limit of $\mathbf{0 . 0 5 0}$ in the regression |  |  |
| :---: | :--- | :--- |
| 1 | Systolic Blood Pressure | $\mathrm{p}<0.001$ |
| 2 | Cholesterol | $\mathrm{P}<0.001$ |
| 3 | Built | $\mathrm{P}<0.001$ |
| 4 | Type of Work | $\mathrm{P}<0.001$ |
| 5 | Family History of CHD | $\mathrm{P}<0.001$ |
| 6 | Diastolic <br> Pressure | $\mathrm{P}=0.003$ |
| 7 | Family Size | $\mathrm{P}=0.041$ |
| 8 | Smoking | $\mathrm{P}=0.012$ |
| 9 | Diabetes Mellitus | $\mathrm{P}=0.028$ |
| 10 | Tobacco Chewing | $\mathrm{P}=0.032$ |

The relationship between physical activity and the prevalence rate has been studied extensively by many workers, and they reported that physical activity protects individual from the effect of CHD. In epidemiological study of CHD in Gurgaon district [12] sex wise prevalence in those who were doing heavy physical activity was found 8.0 in males and 5.5 in females. Among those who were engaged in light physical activity the respective figures were 13.8 and 8.3 per thousand. Present study supports these findings though there is no independent relationship [13].The sedentary type of work however has shown significant independent association in the multivariate analysis. Family history of CHD had shown independent relation with CHD.Chadda S. L. et al [11] found family history of CHD associated with occurrence of CHD. In that study $25.8 \%$ of subjects had given positive family history of CHD. The hypertensive's were more among cases in both sexes in all age groups. The mean systolic blood pressure of CHD cases was 161.8 mm of Hg (SD - 18.4 \& $\mathrm{SE}-1.35$ ) while mean diastolic blood pressure was 97.6 mm of $\mathrm{Hg}(\mathrm{SD}-10.3 \& \mathrm{SE}-0.76)$. Among controls the mean systolic blood pressure was 127.3 mm
of $\mathrm{Hg}(\mathrm{SD}-14.8 \& \mathrm{SE}-1.08)$ while mean diastolic blood pressure was 81.8 mm of Hg (SD-8.3 \& SE0.61 ). However systolic rather than diastolic blood pressure was more strongly related independently. In epidemiological study of CHD in Delhi [11], hypertension emerged as the strongest associated risk factor in CHD in both sexes. The $43.8 \%$ of subjects, $42.1 \%$ of males and $46.2 \%$ of females were having hypertension. Among cases 6 males (4.8\%) and 11 females ( $18.3 \%$ ) were suffering from Diabetes while in controls only 1 male ( $0.8 \%$ ) and 1 female ( $1.7 \%$ ) were suffering from it. The mean fasting blood sugar level was 104.4 (SD-27.8 SE- 2.03 ) while mean post lunch sugar was 142.6 (SD-40.0 SE - 2.93) among cases. Among controls, the mean fasting blood sugar level was 93.9 (SD-13.4 SE-1.04 N -164) while mean post lunch sugar was 132.3 (SD-12.6 SE- $0.99 \mathrm{~N}-160$ ). Only $5.5 \%$ of controls had fasting blood sugar levels above 120 $\mathrm{mg} / \mathrm{dl}$ while $11.9 \%$ cases fasting blood sugar was above $120 \mathrm{mg} / \mathrm{dl}$.Chadda S. L. et al [11] found relationship of diabetes with CHD. Among the $15.8 \%$ of clinically diagnosed CHD cases, $17.5 \%$ males and $13.4 \%$ females were suffering from diabetes.

Table 3: Variables in Logistic Regression

| Variable "Study Type" valued as Control (0) and Case (1) <br> was put for regression with following variables |  |  |
| :--- | :--- | :--- |
| A | Family History of CHD | No / Yes |
| B | Family risk of Hypertension | No / Yes |
| C | Hypertension | No / Yes |
| D | Diabetes Mellitus | No / Yes |
| E | Systolic Blood Pressure above 160 mm of Hg | No / Yes |
| F | Diastolic Blood Pressure above 104 mm of <br> Hg | No / Yes |
| G | Cholesterol level above $220 \mathrm{mg} / \mathrm{dl}$ | No / Yes |

Among cases cholesterol levels were high. The $73 \%$ (SD-41.1 SE-3.0) while of the controls was 197.96 of cases were having cholesterol levels above $240 \mathrm{mg} / \mathrm{dl}$ while only $13.4 \%$ controls had levels above $240 \mathrm{mg} / \mathrm{dl}$. (SD - 34.2 SE - 2.5). Chadda S. L. [11] had found cholesterol more than $200 \mathrm{mg} / \mathrm{dl}$ in $30 \%$ of CHD cases. [13]The mean total cholesterol of the cases was 255.30

Table 4: Classification Table for "Study Type"

|  |  | Predicted |  | Percent |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Control | Case | Correct |
| Observed | Control | 168 | 18 | $90.32 \%$ |
|  | Case | 14 | 172 | $92.47 \%$ |
|  |  | Overall |  | $\mathbf{9 1 . 4 0 \%}$ |

As the Table 4 shows the logistic regression derived has shown overall $91.40 \%$ correctness in observed and predicted values. In many studies it was found that ear lobe crease, hair in ear and baldness were incidentally associated with CHD. But many of these studies are hospital based and to date no population based
epidemiological study has been taken to find the causal relationship.[14]The presence of ear lobe crease is due to deposition of fat and rather related with obesity. Though in present study Chi Square test was significant, it failed to show independent association which is more important to establish a new factor as a risk factor.

Table 5: Logistic Regression Equation

| Variable for Control=0 \& Case=1 |  | B | Exp (B) | Significance |
| :--- | :--- | :--- | :--- | :--- |
|  | Constant | -3.98 |  |  |
| A | Family History of CHD | 2.67 | 14.45 | $\mathrm{P}<0.001$ |
| B | Family History of HT | 2.66 | 14.30 | $\mathrm{P}<0.001$ |
| C | Hypertension | 2.34 | 10.41 | $\mathrm{P}<0.001$ |
| D | Diabetes | 3.22 | 25.06 | $\mathrm{P}=0.002$ |
| E | Systolic BP $>160$ | 1.69 | 5.42 | $\mathrm{P}=0.003$ |
| F | Diastolic BP $>104$ | 1.76 | 5.81 | $\mathrm{P}=0.057$ |
| G | Cholesterol $>220$ | 2.46 | 11.71 | $\mathrm{P}<0.001$ |

In majority of cases i.e. 133 (71.6\%) more than $20 \%$ of calories of the total caloric intake were derived from fat. But only $3.8 \%$ cases were eating fats amounting $30 \%$ or more of total calories. In controls the corresponding figures were $82(44.1 \%$ ) and $2.7 \%$ respectively.[13].However it failed to show independent relation with Coronary Heart disease
(CHD).Considering limitations of 24 hour recall survey method of dietary survey included in the study, it needs further evaluation.

Among cases there were 58 (31.2\%) alcohol consumers while among controls 53 ( $28.5 \%$ ). There was no significant difference found among two groups. [13]

Table 6: Prediction of Risk using Logistic Regression

| Factor | Probability | Factors | Probability | Factors | Probability |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A | 0.212486 | A + B | 0.794129 | C+D + E | 0.963385 |
| B | 0.210818 | A + D | 0.869891 | $\mathrm{C}+\mathrm{D}+\mathrm{G}$ | 0.985797 |
| C | 0.162465 | A+G | 0.759510 | $\mathrm{C}+\mathrm{E}+\mathrm{B}$ | 0.937614 |
| D | 0.318646 | C + D | 0.829204 | $\mathrm{C}+\mathrm{E}+\mathrm{F}$ | 0.859361 |
| E | 0.091954 | $\mathrm{C}+\mathrm{E}$ | 0.512497 | $\mathrm{C}+\mathrm{E}+\mathrm{G}$ | 0.924839 |
| F | 0.097568 | D + G | 0.844434 | All factors absent: $\mathbf{c}=\mathbf{- 3 . 9 8}$ |  |
| G | 0.179461 | All factors present: $\mathrm{c}=12.82 ; \mathrm{P}=1 / 1+\mathrm{e}^{\mathrm{c}}=\mathbf{0 . 9 9 9 9 9 7}$ |  |  |  |

Among cases $66.7 \%$ (124) were smokers while among the controls $58.1 \%$ (108) were smokers. As a rough estimation $48.4 \%$ cases had smoked more than 3 lakh cigarettes or bidis while only $20.5 \%$ controls had smoked that much number of bidis or cigarettes. The observed difference was statistically significant ( $\mathrm{P}<$ 0.001 ). [13] Also there was independent association. In epidemiological study of CHD in Delhi [11] smoking did not show independent association with CHD, though it was present in $36.5 \%$ males and $5.9 \%$ females. The criteria used was, person smoking 10 cigarettes per day for two years or more at the time of survey.

Among cases 103 (55.4\%) were tobacco chewers while among controls 84 (45.2\%). The observed difference among two groups was significant statistically ( $\mathrm{P}<0.05$ ). It had also shown independent relation and needs further evaluation.

As Table 6 shows, with presence of two factors probability rises steeply and after the presence of three factors there is no much scope for the improvement.

## Conclusion \& Recommendations

The present epidemiological study indicates that among multiple risk factors of Coronary Heart Disease,Systolic Blood Pressure, Cholesterol, built, Type of work, family history of CHD, Diastolic Blood Pressure, Family size, Smoking, Diabetes Mellitus and Tobacco chewing are having significant independent effect even in urban slum population having predominantly low socio-economic status.
The Systolic Blood Pressure \& Cholesterol have most significant effect.Cholesterol levels have significant association with occurrence of CHD as well independent association ranking next to systolic blood pressure.

Family size as risk factor is surprising. May be it is attributable to more amount of stress in lower Socio Economic Class with higher family size.

Sedentary type of work is significantly associated with Coronary Heart Disease and the association is independent.More attention is needed to type of work in view of modification of behaviour. Obesity is associated with CHD significantly but do not have independent
association in terms of body mass index however built of the person is independently related with CHD. This needs further evaluation. There is a need of further evaluation for factor entered on last step that is tobacco chewing. Dietary factors like high caloric intake, high fat content of dietand extra salt in diet are significantly related with CHD but failed to show independent effect. With presence of Family History of both Coronary Heart Disease \& Hypertension the probability is 0.79 while family history of either of these results in probability of 0.21 of suffering from Coronary Heart Disease. When all Factors are present probability of suffering from Coronary Heart Disease is 0.999 while in absence of all factors it is 0.018 . With presence of two factors in Logistic Regression model probability increases steeply. After inclusion of third factor there is not much scope to change. In view of these findings and in order to combat this newly emerging Public Health Problem, a multipronged attack need to be launched at multiple levels, considering Prevention is the best solution.

Health educational programmes should include knowledge about risk factors and behaviour change communication for avoidance of CHD through healthy life styles.Furthermore use of mass media can enhance community participation and improve dissemination of much needed information. It can also demonstrate appropriate behaviour and teach skills needed to achieve behavioural changes. Use of mass media along with sustained personal reinforcement over a long period can definitely help effectively to curb the widely spreading disease.

The large community based epidemiological studies is the need of time. It will help the policy makers to chalk out programmes to minimize the extent of the problem of CHD.

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