

D. H. Trivedi<sup>1</sup>, Vinit Sharma<sup>1</sup>, Himanshu Pandya<sup>2</sup>, R. K. Arya<sup>1</sup>,  
Rajesh Mehta<sup>1</sup>, R. K. Bansal<sup>1</sup>, Anuragini Sharma<sup>1</sup>, S. P. Gandhi<sup>2</sup>

<sup>1</sup> Department of Community Medicine, Pramukhswami Medical College &  
S. K. Hospital, Karamsad/Gujarat

<sup>2</sup> Department of Medicine, Pramukhswami Medical College &  
S. K. Hospital, Karamsad/Gujarat

## Longitudinal epidemiological study of coronary heart disease in a rural population of Kheda district, Gujarat, India

### Summary

The present study was undertaken to determine the incidence and related risk factors for coronary heart diseases and hypertension in the rural population of Kheda district, Gujarat (India). The observations from the first five years of this ongoing project (May 1987–May 1992) are described in this paper. Out of an initial sample of 750 individuals in the age group 30–62 years, who were selected by stratified random sampling, 714 persons (males=429; females=285) were actually studied, after excluding those suffering from coronary heart diseases (CHD). Initially, all the included subjects were examined clinically and appropriate laboratory investigations were done. A detailed socio-economic history was also obtained. Subsequently all of them were followed up and biannual clinical and laboratory investigations were performed. Cases of CHD were diagnosed according to the recommendations of the New York Heart Association. The overall five-year incidence of CHD was 25.17 per thousand persons. The incidence in males was 3 times higher than in females. More males suffered from myocardial infarction (MI), while in the females the incidence of sudden death was higher (33.3%). The average yearly mortality rate due to CHD was 2.46 per thousand persons. CHD was significantly associated with increased blood pressure (both diastolic and systolic), smoking, and family history of heart disease, and was weakly associated with body weight ( $p=0.06$ ).

Coronary Heart Disease (CHD) has assumed great public health importance during the last few decades<sup>1</sup>. Even in developing countries like India, it is increasingly being recognised as a major health problem, and rapid urbanisation and modifications in life-

style have been identified as important contributing factors for this change<sup>2–5</sup>. A number of hospital-based studies and cross-sectional community surveys have been conducted in India to assess the prevalence and magnitude of the problem in the community<sup>2–21</sup>, but

there is a paucity of data regarding the incidence of CHD.

The present longitudinal, community-based, epidemiological study was undertaken to determine the incidence of and related risk factors for CHD. The study was planned on the lines of the Framingham Heart Study, U.S.A.<sup>1</sup> and was started in May 1987. The results of the first five years' experience (1987–1992), and some observations made, are described in this paper.

### Methods

Kheda district in Gujarat is well known for milk production and well-organised dairy co-operatives. This district is also one of the leading tobacco growing areas of India. For the purpose of this study, Dharmaj, a small town situated 25 km away from Pramukhswami Medical College, was selected. It has a population of 10,300 and is fairly representative of a typical rural area of the district. The town was purposively selected, taking into consideration the feasibility of the study.

At the onset, a meeting of Gram Panchyat members, and representatives of other voluntary agencies and trusts, was convened. The

objectives and purpose of the study were explained to them and their cooperation was solicited. A list of all the persons in the age group 30–62 years was prepared from the voters' list. Out of the 3800 persons thus obtained, a sample of 750 was selected by the process of stratified random sampling, so as to obtain a proportionate representation from each ward. A house-to-house survey of the selected individuals revealed that 80 had either died or left the area. Of the remaining 670 persons only 296 (44.2%) came for the initial check-up. Hence, a second list of 420 persons was made from the sampling frame of 3800. Out of these only 161 persons (38.3%) reported, so a third list of 290 persons had to be made from the same sampling frame, of whom 92 (31.7%) came for clinical examination. A particularly poor response was observed from people in the lower socioeconomic stratum. Hence, it was decided to contact members of this population group personally with the help of local leaders, and to invite volunteers from this for inclusion in the study. Eventually, 76.1 percent ( $n = 296 + 161 + 92 = 549$ ) of the persons who constituted the study population were selected by quasi-random sampling, whereas 23.9% ( $n = 172$ ) were volunteers. Out of the final list of 721 persons, 2 did not complete the examination and ultimately a list of 719 persons was finalised. On initial examination 5 persons showed evidence of CHD as suggested by clinical examination and/or ECG abnormality, and had to be excluded from the study, so a total sample of 714 persons was followed up.

All subjects were examined in a clinic set up at the Jilla Panchayat hospital in Dharmaj. About 10 subjects were called to the clinic every day. Social workers and one staff member visited the houses of the persons to be called during the previous evening, and persuaded them to come to the clinic the next

morning. In the clinic, a detailed history and physical examination was completed by a physician and entered in a pretested, structured proforma. Data regarding socioeconomic variables, life styles, physical activity, addictions, etc. were recorded in a separate form by a social worker. Separate files were maintained for individual persons, and results of subsequent follow-up clinical examinations were entered therein.

Besides personal and socioeconomic variables, the following parameters were also recorded: blood pressure (left arm, sitting posture, fifth sound considered for diastolic reading); ECG; blood sugar (fasting and 2 h after a meal of 75 g glucose); serum cholesterol; serum triglycerides; serum high density lipoproteins; serum low and very low density lipoproteins. Kuppuswamy's socioeconomic status scale, urban (based on income, occupation and education) was used to determine the socioeconomic status<sup>22</sup>. A diagnosis of CHD was made according to the recommendations of the New York Heart Association<sup>1</sup>. In all cases which were diagnosed as suffering from CHD, or who had suffered from CHD between two consecutive clinical rounds, efforts were made to confirm the diagnosis by obtaining medical records, ECG, etc from the concerned treating doctor or hospital.

## Results

The first round of initial examinations started on 19th May, 1987 and ended on 15th January, 1988. The second round started after six months and ended on 18th May, 1988. All subsequent clinical rounds of examination were repeated in a similar fashion and their details are given in Table 1. Due to technical constraints, the biochemical estimations on blood samples could not be repeated

after the first round; however, for diabetics blood sugar estimation was repeated frequently.

It was observed that the overall five-year incidence of CHD (defined as myocardial infarction; angina pectoris and sudden death) was 25.17 per thousand<sup>1</sup>. The population at risk was composed of all subjects who were free from CHD at the time of entry into the study ( $n = 714$ ). The five-year incidence in men was about three times more than in women (35.04:10.4). Out of the 15 males who developed CHD, only 2 were in the age group 30–44 years, while there was no female patient in this age group. The data for persons who developed CHD has been adjusted for age.

The incidence of CHD and mortality by year are depicted in Table 2. The persons at risk for each year have been calculated on the basis of life-table analysis i.e. excluding half the number of cases removed from the study due to emigration or death during the year. Out of 18 deaths due to all causes during the study period, 8 deaths were due to CHD, which thus accounted for 44% of all deaths.

With reference to the clinical manifestations of CHD, it was observed that 60% of the male patients had myocardial infarction, 33.2% had angina pectoris and 6.6% sudden death. In women all these manifestations were equally distributed (Table 3).

A highly significant difference ( $p < 0.0001$ ) was observed between the mean systolic blood pressures of persons who developed CHD (143.88 mmHg + 26.29) and those who did not develop the disease (124.29 mmHg + 20.14). The prevalence of hypertension exhibited an increasing trend with increasing age, being lowest in the age group of 30–39 years (5.13%) and highest in the age group of 50 years and above (25.25%). However, the data for persons who developed CHD have been adjusted for

Round	Year	Persons at beginning of year	Emigrations	Deaths	Immigrations	Persons at the end of year	Persons examined	%
I	1987–88	714	21	–	–	693	714	100.0
II	1988–89	693	8	2	–	683	580	83.5
III	1988–89	683	6	4	–	673	669	97.8
IV	1989–90	673	5	4	–	664	570	84.5
V	1990–91	664	8	4	–	652	552	83.0
VI	1991–92	652	–	2	1	651	651	100.0

**Table 1.** Details of the various rounds of clinical examination.

Year	Persons at risk	Incidence of new cases	CHD rate	95 % C. I.	Mortality from no. of deaths	CHD rate	Overall mortality
1987–88	699	4	5.72	1.5, 14.6	1	1.43	2
1988–89	678	5	7.36	2.4, 17.1	2	2.94	4
1989–90	669	4	5.97	1.6, 15.2	2	2.98	4
1990–91	658	3	4.55	0.9, 13.3	1	1.58	4
1991–92	600	2	3.02	0.3, 10.9	2	3.01	4
Overall Five Years' Incidence (per thousand persons)	=		25.17	15.0, 39.1			
Males	=		35.04	19.7, 57.0			
Females	=		10.40	2.1, 30.4			

**Table 2.** Yearwise incidence of CHD and mortality rate (per 1000 persons).

Clinical manifestations	Male cases	incidence (per 1000)	Female case	incidence (per 1000)	Male & female Total (Incidence rate)
Angina	5	11.63	1	3.57	8.39
M. I.	9	21.00	1	3.51	14.00
Sudden death	1	2.30	1	3.51	2.80
Total	15	35.04	3	10.04	25.17

**Table 3.** Incidence of CHD according to clinical manifestations.

Clinical round	Persons under study	CHD	Cerebral haemorrhage	Renal disease	TB*	Other diseases	Total	CDR**
1987–88	699	1	–	–	–	1	2	2.86
1988–89	678	2	–	1	1	–	4	5.89
1989–90	669	2	–	–	2	–	4	5.97
1990–91	658	1	2	–	–	1	4	6.05
1991–92	660	2	–	1	–	1	4	6.05
	Total	8	2	2	3	3	18	5.47

\* TB = Tuberculosis, \*\* CDR = Crude Death Rate.

**Table 4.** Yearwise deaths due to all causes in the study population.

Characteristics	New CHD cases developed	No CHD	Total
1. A positive family history of CHD and/or angina	3 (5.0%)	57	60
2. No family history of CHD or angina	15 (2.3%)	640	655
3. A positive family history of hypertension/diabetes/stroke	10 (4.3%)	225	235
4. No family history of hypertension/diabetes/stroke	8 (1.7%)	471	479

**Table 5.** Relationship of family history with incidence of disease.

age. The diastolic blood pressure readings of the two groups (CHD cases = 91.22 mmHg + 15.04, and non-CHD persons = 81.07 mmHg + 12.21) showed a similar pattern, and the difference was highly significant ( $p < 0.001$ ). A high degree of association was observed between hypertension and CHD, as 8.1% of the hypertensives developed CHD, while only 1% of the normotensives and 1.7% of the borderline cases subsequently suffered from CHD.

The five-year incidence of CHD among smokers was 50.5 per thousand persons while among non-smokers it was 15.5‰. Thus, it was about three times more among smokers than non-smokers the incidence of CHD was 66.2‰ for those smoking more than 10 cigarettes per day as compared to an incidence of 14.2‰ among

those who smoked less than 10 cigarettes daily, or had currently stopped smoking.

Among the diabetics, the five-year incidence of CHD was 45‰ as compared to an incidence of 24.7‰ in the non-diabetic population. Statistically this difference was not significant. Similarly, no significant difference was observed ( $p = 0.06$ ) between the body weights of those who developed CHD (mean weight = 63.93 Kg + 14.87) and those who did not develop the disease (mean weight = 57.92 Kg + 12.98).

The five-year incidence among persons having a positive family history of CHD or angina was 50‰, while among those with no family history it was 23‰ ( $p = 0.29$ ). But when the family history for any one of the five related diseases, i.e. CHD, angina pectoris, hyperten-

sion, stroke or diabetes, was considered, the incidence of CHD in those with a positive family history was 43‰, while in persons with no family history it was 17‰ (Table 5). Statistically this difference was significant ( $p = 0.003$ ).

Serum cholesterol levels for all the subjects included in the study were measured at the time of initial survey, but could not be repeated subsequently due to technical constraints. The mean serum levels for those who developed CHD and those who did not develop CHD are presented in Table 6. Statistically the differences are not significant. Similarly, the mean serum triglyceride levels for CHD cases (94.8 gm/dl + 38.8) and non-cases (100 gm/dl + 47.4) were not significantly different.

Characteristic	Mean cholesterol level (gm/dl)	Mean HDL cholesterol (gm/dl)	Mean LDL cholesterol (gm/dl)
1. New CHD cases	191.5 + 33.2	45.5 + 11.0	126.6 + 34.2
2. Population at risk	184.2 + 42.5	50.6 + 18.9	113.1 + 37.2

**Table 6.** Mean serum HDL, LDL, Cholesterol levels in cases of CHD and non-cases.

## Discussion

Almost 24% of the sample in the present study was made up of volunteers. It might be argued that the sample was thus biased. It was, however, unavoidable, because in the absence of this volunteer group, the population from the lower socioeconomic strata of the society would have been very poorly represented, and that could have yielded spurious or skewed results. In the Framingham study also, volunteers constituted a part of the total sample<sup>1</sup>.

The overall five-year incidence of coronary heart disease in our study was 25.17%, which is lower than the incidence of 30.25% reported in the Framingham heart study<sup>1</sup>. The incidence of CHD in both the male and female populations of our study are lower than those observed in the Framingham study (which gave: males=45.17% and, females 17.63%) though the differences in incidence of the disease in males and females are almost comparable.

There were no cases of CHD in women in the age group 30–44 years in our study, and the Framingham study also reported a very low incidence of the disease in this population. In the older age groups (45–62 years) we observed an incidence about three times higher in males than in females, while the Framingham study reported a difference of about two times in this group. The Framingham study reported a preponderance of angina pectoris cases among women, whereas in the

present study the various clinical manifestations of CHD were almost equally distributed in the female cases. This might be due to the small number of female cases in our study (n=3).

We found a high degree of association between hypertension and the risk of developing CHD. The incidence of CHD among hypertensives was 4.16 times more than that observed among the normotensives, and the difference was highly significant statistically. Almost similar findings were reported by the Framingham study, which also identified hypertension as an important risk factor for CHD<sup>1,23</sup>. In our study population 27.8% of the subjects were smokers (n=188) of which a majority were males (n=187). Ladies in India generally do not smoke and this might be one of the factors responsible for low prevalence of CHD among women in India. The five-year incidence among male smokers was about 2.28 times more than among non-smokers, and statistically this difference was not significant (p=0.17). However, when the smokers were subdivided into two groups according to smoking pattern, it was observed that the incidence of CHD among those males who smoked more than 10 cigarettes daily was significantly higher than that among those who were either non-smokers or smoked less than 10 cigarettes per day (p=0.002). However, when considering the total study population, we observed a highly significant difference between the incidence of CHD among smokers and

non-smokers, and the relative risk of development of CHD among smokers was 1.64<sup>23</sup>.

The Framingham study reported a definite association between mean cholesterol levels and the subsequent risk of development of CHD<sup>1,23,24</sup>, whereas we failed to observe any significant difference between the mean serum cholesterol levels of those who developed CHD and those who did not develop the disease. Similarly, no significant difference could be observed between the mean serum levels of HDL cholesterol; LDL cholesterol; VLDL cholesterol and serum triglycerides, although we did notice higher serum levels of these in those who developed CHD as compared to the population at risk<sup>18,19</sup>. One of the reasons for this discrepancy might be the fact that in our study only findings from the initial survey were available. The persons with high serum cholesterol levels had been informed about the results and had been educated about modifications in their life-styles and dietary habits, and there is a possibility that some of them might have complied with the advice given to them. Furthermore, the mean cholesterol levels of our study population in general were much lower in comparison to those of the various age groups in the Framingham study.

The five-year incidence of CHD among diabetics, in our study, was almost twice that among non-diabetics, but statistically this difference was not significant. These findings are comparable to those from the Framingham study<sup>25</sup>.

A weak statistical association was observed between body weight and CHD ( $p=0.06$ ), with the mean body weight of CHD cases being almost 6 kg more than that of the population at risk. Similarly, a positive history of CHD and/or angina was not significantly associated with the future risk of developing CHD ( $p=0.39$ ). But when a family history of any one of the related disease, i.e. CHD; angina pectoris; stroke; hypertension, or diabetes was considered, a highly significant difference was discernible.

The present study, with the obvious limitation of a small sample size, is an attempt to study and analyse the incidence of CHD and its related risk factors in a rural population in the state of Gujarat, India. Even with the constraint of limited resources, we have been able to obtain results fairly comparable to those of the Framingham study<sup>1,23–25</sup>, and some earlier studies conducted in India<sup>4,7,9–13,18,19</sup>.

### **Zusammenfassung**

#### **Longitudinale epidemiologische Studie zu den koronaren Herzkrankheiten in der ländlichen Bevölkerung des Kheda Distriktes, Gujarat, Indien**

Diese Studie wurde zur Bestimmung der Inzidenz der koronaren Herzkrankheiten und des Bluthochdruckes sowie der assoziierten Risikofaktoren in der Bevölkerung des Kheda Distriktes, Gujarat, unternommen. Die vorliegende Arbeit stellt die Resultate aus den ersten fünf Jahren dieses immer noch laufenden Projektes vor. 714 Personen im Alter von 30–62 Jahren wurden studiert. Alle einbezogenen Probanden wurden klinisch und labormässig untersucht. Eine detaillierte sozio-ökonomische Anamnese wurde erhoben. In der Folge unterlagen alle Teilnehmer zweimal jährlich einer klinischen und einer labormässigen Untersuchung. Die Fälle von KHK wurden gemäss der Empfehlungen der New York Heart Association diagnostiziert. Die 5-Jahres Inzidenz der KHK lag bei 25,17%. Die Inzidenz bei den Männern war dreimal höher als diejenige der Frauen. Während die Männer vermehrt unter Herzinfarkten litten, kamen bei den Frauen plötzliche Todesfälle häufiger vor. Es bestand eine signifikante Assoziation zu erhöhten Blutdruckwerten, zum Rauchen, zu einer Familienanamnese für Herzkrankheiten und eine schwache Assoziation zum Körpergewicht.

### **Résumé**

#### **Les maladies cardio-vasculaires dans le district de Kheda, Gujarat, Inde: Résultats d'une étude prospective longitudinal**

Une étude a été conduite dans le district Kheda (Gujarat, Inde), pour mesurer l'incidence de la maladie coronarienne, de l'hypertension artérielle et de leurs facteurs de risque. Les résultats des 5 premières années de l'étude, sont présentés ici. Un échantillon de 714 personnes de 30 à 62 ans a été sélectionné par un échantillonnage aléatoire de la population à partir des listes électorales. L'échantillon étudié ont été soumises à un premier examen clinique complet, et à un interrogatoire socio-démographique. L'examen clinique sont répétés deux fois par an chez tous les sujets. Les MCV ont été diagnostiqués selon les critères de la New York Heart Association. Sur les cinq ans d'observation, l'incidence des MCV est de 25,17 pour mille personnes, avec une incidence trois fois plus élevée chez les hommes que chez les femmes. L'incidence de l'infarctus du myocarde est plus importante chez les hommes alors que la mort subite est plus fréquente chez les femmes. La survenue d'une MCV est associée de façon significative avec une augmentation de la tension artérielle, avec le fait d'être fumeur, avec des antécédents familiaux de MCV et avec la masse corporelle ou le poids.

---

**References**

- 1 Kannel WB, Dawber TR, Kagan, A et al. Factors of risk in the development of coronary heart disease – six years follow up experience: The Framingham study. *Annals of Internal Medicine* 1961; 55:33.
- 2 Vakil RJ. Heart diseases in India. *Am Heart J* 1954; 48:439.
- 3 Mathur KS, Kumar V, Sharma RD, et al. Aetiology and incidence of heart disease, changing pattern over the fifteen year period, 1947–1961. *J of Association of Physicians of India* 1963; 11:651.
- 4 Jhatakia KU. Incidence and etiology of coronary heart diseases. *J of Association of Physician of India* 1966; 14:283.
- 5 Padmavati S, Kumar S, Sandhu I. Five years experience of coronary heart diseases in Delhi. *Indian Heart J* 1968; 10:333.
- 6 Padmavati S. Epidemiology of cardiovascular diseases in India-(II). Ischemic Heart Diseases. *Circulation* 1962; 25:711.
- 7 Naik B. Incidence of coronary heart disease in Hyderabad. *Indian Heart J* 1986; 18:358.
- 8 Samani OT. Coronary heart disease in low income group population in India. *Indian Heart J* 1956; 8:104.
- 9 Banerjee JC. Incidence of coronary heart disease in India. *Indian Heart J* 1960; 12:171.
- 10 Dattay KK, Bharucha PE, Bhatt RM, et al. Incidence of various aetiologies of heart disease in Bombay. *Indian Heart J* 1965; 17:293.
- 11 Bhargava RK, Dhoot BM, Singh D. Incidence of heart disease in Rajasthan. *Journal of Association of Physician of India* 1965; 14:15.
- 12 Vakil RJ. Ischemic heart disease in India. *British Heart J* 1963; 25:283.
- 13 Sinha BC. Pattern of ischemic heart disease in India. *Journal of Indian Medical Association* 1970; 55:171.
- 14 Vyatilingam KL. Incidence and epidemiology of CHD in South India. *J of Association of Physician of India* 1966; 14:289.
- 15 Dawn BD, Malhotra KC, Gupta SP. Epidemiological study of coronary heart disease in rural community in Haryana. *International Heart J* 1973; 26:68.
- 16 Servothan SG, Berry JN. Prevalence of coronary heart disease in urban population of Northern India. *Circulation* 1968; 37:82.
- 17 Sinha PR, Gaur SD, Somani PN. Prevalence of coronary heart disease in an urban community of Varanasi. *Indian J of Community Med* 1990; 15:74.
- 18 Padmavati S. Dietary fat, serum cholesterol and incidence of coronary arteriosclerosis and hypertension in Delhi. *Indian J Medical Res* 1958; 45:245.
- 19 Padmavati S, Gupta S, Pantululu GV. Dietary fat, serum cholesterol levels and incidence of arteriosclerosis in Delhi. *Circulation* 1959; 19:849.
- 20 Mathur KS, Patney NL, Kumar V, et al. Prevalence of CHD in general population of Agra. *Indian J Medical Res* 1961; 69:605.
- 21 Gupta SP, Malhotra KC. Urban rural trends in epidemiology of coronary heart disease. *J Association of Physician of India* 1975; 23:885.
- 22 Kuppuswamy K. Manual of Socio-economic status scale (urban). New Delhi: Mansayan Manasnagar, 1972.
- 23 Kannel WB. Hypertension, blood lipids and cigarette smoking as co-risk factors for CHD. *Annals of New York Academy of Sciences* 1978; 304:128.
- 24 Kannel WB, Castelli WP, Gordon T. Cholesterol in the prediction of atherosclerotic diseases. New perspectives based on the Framingham study. *Circulation* 1979; 59:8
- 25 Kannel WB, McGee DL. Diabetes and cardiovascular risk factors – the Framingham study. *Circulation* 1979; 59:8.

---

**Acknowledgements**

The Authors acknowledge their gratitude to the Charutar Arogya Mandal Medical Research Society, Karamsad for sponsoring this project. The authors are grateful to Prof. Fred Paccaud and Jean-Pierre Gervasoni who kindly reviewed the earlier version of this manuscript.

---

**Address for correspondence**

Prof. Vinit Sharma  
 Department of community Medicine  
 Pramukh Swami Medical College &  
 S. K. Hospital  
 IND-388 325 Karamsad, Gujarat