PREVALENCE AND RISK FACTORS OF CORONARY HEART DISEASE IN A RURAL POPULATION OF BANGLADESH

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Abstract

Coronary heart disease (CHD) is a major global health problem with the majority of burden observed increasingly in the developing countries. There has been no estimate of CHD in Bangladesh. This study addresses the prevalence of CHD in a Bangladeshi rural population which also aimed to determine the risk factors related to CHD. Ten villages of Nandail sub-district under Mymensingh were selected purposively. All subjects of age ≥20y were considered eligible and were interviewed about family income, family history of T2DM, CHD and HTN. The investigations included height, weight, waist-girth, hip-girth, systolic and diastolic blood pressure (SBP & DBP), fasting blood glucose (FBG), triglycerides (TG), cholesterol (Chol) and high density lipoprotein (HDL). Hemoglobin A1c (HbA1c) and albumin-creatinine ratio (ACR) were also estimated. Finally, electrocardiography (ECG) was undertaken in all participants who had family history of diabetes or hypertension or CHD. Diagnosis of CHD was based on history of angina or changes in ECG or diagnosed by a cardiologist. A total of 6235 subjects were enlisted as eligible (age ≥20y) participants. Of them, 4141 (m / f: 1749 / 2392) subjects volunteered for the study. The age-adjusted (20-69y) prevalence of CHD was 1.85 with 95% CI, 1.42 – 2.28. There was no significant difference between men and women. The mean (SD) values of age ($p < 0.001$), SBP ($p < 0.01$), DBP ($p < 0.05$), HbA1c ($p < 0.05$) and ACR ($p < 0.01$) were significantly higher among subjects with CHD than those without; whereas, there were no significant differences in BMI and WHR, TG, Chol and HDL. Logistic regression analysis showed that adjusted for age, sex, social class and obesity, the subjects with higher age (≥45y), higher 2hBG (≥7.0mmol/l), higher ACR (≥17.2) and family history of CHD had significant risk for CHD. The prevalence of CHD is comparable with other Asian population. Family history of CHD and age over 45 years, and who had hyperglycemia and higher ACR were proved to be the independent predictors of CHD. CHD was found to affect participants irrespective of sex, social class, obesity and lipid status. Though the IFG and diabetes groups appeared to have similar biophysical characteristics, only the diabetes group had significant risk for CHD. Further study in a larger sample may be undertaken to confirm the study findings and to explore some unidentified risk factors of CHD.

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Acronyms: ACR – albumin to creatinine ratio, BMI – body mass index (weight in kg / height in meter squared), CI – confidence interval, BP: SBP & DBP – blood pressure: systolic & diastolic, CHD – coronary heart disease, Chol – total cholesterol, FBG – fasting blood glucose, 2hBG – 2h post load glucose, HbA1c – hemoglobin A1c, HDL – high-density lipoprotein, HTN – hypertension, IFG – impaired fasting glucose, LDL – low-density lipoprotein, NFG – normal fasting glucose, OGTT – oral glucose tolerance, OR – odds ratio, SD – standard deviation, TG – triglycerides, T2DM – Type 2 diabetes mellitus, WHR – waist-to-hip ratio, WHtR – waist-to-height ratio.

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Introduction

Morbidity and mortality from coronary heart disease (CHD) have increased to an epidemic form in the past several decades. A substantial number of reports indicate that the prevalence of CHD has increased both in the developed and in the developing countries.[1-4] Recently published reports suggests that CHD is related to social deprivation and low socio-occupational classes.[5,6] It is well known that Bangladesh is one of the least developing countries and its per capita GNP is one of the lowest (USD 370) in the world.[7] Another important and relevant consideration is that CHD is the leading cause of death among individuals with diabetes.[8] The information on CHD and its association with known risk factors in populations with high rates of diabetes is limited and the influence of known duration of diabetes was not observed to be a significant contributor to the cardiovascular risk factors.[9] The risk factors were found to be significant in the sub-sample of patients with duration of diabetes even less than 15 years. As regards diabetes, Bangladeshis were found to have a high prevalence of impaired fasting glucose (IFG: 4 – 12%) and type-2 diabetes (T2DM: 4-11%) in the age group equal to or greater than 20 years.[10-13] Thus, it appears that the people of Bangladesh are likely to develop CHD for the two obvious reasons – first, due to the exposure of social deprivation; and second, there being a high prevalence of diabetes. However, there has been no known study so far conducted to address this issue. This study was undertaken to determine the prevalence of CHD in a sub-sample of the vast majority of rural Bangladesh and to investigate the risk factors acting upon them.

Subjects and Methods

A population of ten villages of Nandail sub-district under Mymensingh was selected purposively. The study area is situated at a distance of ~150 km from Dhaka City. These people live mainly on cultivation. A few of them are involved in small scale business. Very few of them have mixed occupation like service and / or business in addition to their main agrarian origin. A population census was conducted for socio-demographic information. The variables were age, sex, education, occupation, annual income, family size, smoking habits, religion and housing condition. In addition, family history of diabetes, coronary heart disease and stroke was also collected. A questionnaire on the population census was finalized after a field trial. All the collected census data of all age groups were entered into a computer. From this data set, the subjects were enlisted as eligible participants. All men and women of age 20 years or more were considered eligible with the exception of pregnant mothers and of those who were suffering from severe illness.

The objectives and procedural steps were informed to every individual participant for taking consent. Having consent each individual was requested to attend a nearby investigation spot with at least 12h fast. Each participant was interviewed for clinical history, medication and physical activities, and for women, menstrual history to exclude pregnancy [Figure-1]. Measurements of height, weight, and girth of waist and hip were taken with light clothes and barefooted. Blood pressure was measured after 10min rest. Hemocue Cuvettes were used for measuring capillary fasting blood glucose (FBG). The participants were classified into hyperglycemic and normoglycemic groups based on FBG cut-off at 5.6 mmol/l. All the subjects with hyperglycemia (≥5.6mmol/l) were

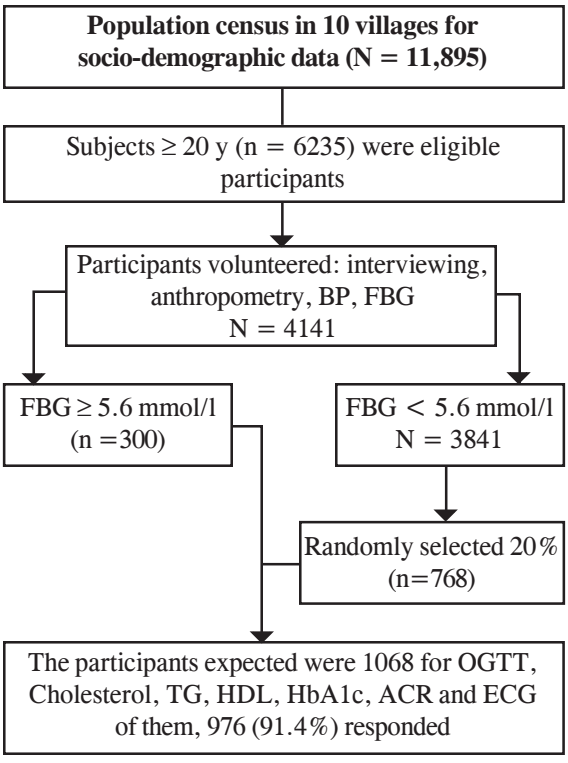

Fig.1: *Algorithm for investigation: ACR-albumin -creatinine ratio, FBG – fasting blood glucose*

considered eligible for further investigations like oral glucose tolerance test (OGTT), total cholesterol (t-chol), triglycerides (TG), high-density-lipoprotein chol (HDL-Chol), hemoglobin A1c (HbA1c), electrocardiogram (ECG) and urinary albumin-creatinine ratio [Figure-1]. Additionally, the normoglycemic (FBG <5.6mmol/l) subjects also had all these investigations but only in randomly selected 20%.

For further investigations, ensuring an aseptic measure, 5 ml of venous blood sample was taken for fasting plasma glucose, total cholesterol, HDL cholesterol, and triglycerides (TG). Following fasting sample collection, a 75g glucose drink was given. We estimated fasting plasma glucose by the glucose oxidase (enzymatic oxidation) method (GOD/PAP Kit; Randox, Antrim, U.K.) using the auto-analyzer Screen Master-3000 (B.S. Biochemical Analyzer, Arezzo, Italy). For 2h-OGTT second sample, only 2ml of venous blood was taken in a fluoridated test tube for estimation of plasma glucose. Urine samples were collected for estimation of urinary albumin by Nephelometry and creatinine by colorometric method. Then the ratio was calculated.

Diagnosis of CHD was based on - a) history of angina plus ECG-positive either on rest or on stress; 2) post-myocardial infarction (MI) with Q-wave MI or non-Q-MI; 3) diagnosis made by a cardiologist. The participants were categorized into subjects with normal fasting glucose (NFG), impaired fasting (IFG) or DM based on FBG <5.6, 5.6 – 6.9 and ≥ 7.0mmol/l, respectively.

Statistical analyses– The prevalence rates of CHD are given in percentages. The socio-demographic, anthropometric and biochemical characteristic are shown in mean with standard deviation (SD). For some variables median and 95% confidence interval were provided when SD exceeded 20%. Chi sq tests were done for the association of CHD with conventional risk variables. Odds ratio was estimated only when a significant association was found. When OR was significant, logistic regression was undertaken to quantify risk for contributing CHD. The level of significance was taken at $p<0.05$ for almost all statistical tests if not otherwise specified. All statistical analyses were carried out by SPSS+ package (Version 10.05).

Results

A total of 6235 subjects of 10 villages were found eligible for the study. Of them, 4141 (m / f = 1749 / 2392) volunteered for the study. The mean (SD) age of the participants was 37.6 (15.2) years and the values for BMI, WHR, SBP, DBP and FBG were 19.4 (2.9), 0.84 (0.07), 120 (18) mmHg, 77 (12) mmHg and 4.7 (0.89) mmol/l, respectively (Table-1a). The participants, as mentioned, were categorized into hyperglycemic (FBG ≥ 5.6) and normoglycemic (FBG <5.6) groups [figure 1]. Further biochemical investigations are also shown in the same table. Hyperglycemia was found in 7.2% (n=300) and normoglycemia in 92.8% (n=3841) subjects. All of

Table 1a: *The anthropometric and biochemical characteristics of the participants (n = 4141)*

Characteristics	Range	Mean (median)*	SD
Age (y)	20.0 – 125.0	37.6	15.2
Men/women(%)	1749/2392 (42.2/57.8)		
BMI	10.7 – 35.2	19.4	2.9
WHR	0.483 – 1.211	0.844	0.068
WHtR	0.197 – 0.698	0.440	0.050
MUAC (cm)	12.6 – 35.5	23.7	2.5
SBP (mmHg)	70.0 – 235.0	120.0	18.0
DBP (mmHg)	20.0 – 140.0	77.0	12.0
FBG (mmol/L)	1.40 – 22.0	4.70	0.89

Table 1b: *Investigations undertaken for the hyperglycemic and randomly selected groups (n = 976)*

	Range	Mean (median)*	SD	95%CI*
HbA1c (%)	3.7–16.2	6.01	1.01	-
Total Cholesterol(mg/dl)	34–372	125 (120.0)	42	121–129
TG (mg/dl)	20–988	112 (92.0)	81	105–117
HDL (mg/dl)	11.0–82	42.8 (42.0)	10.4	42.2–43.5
LDL (mg/dl)	44.0–213	60.6 (58.2)	37.4	58.3–63.0
VLDL (mg/dl)	4.00–198	22.4 (18.4)	16.3	21.4–23.4
Lipoprotein (a)	8.6–113	18.7 (10.9)	14.9	17.8–19.6
ACR	3.9–275	15.72 (12.3)	17.65	17.8–19.6

** - median values with 95% confidence interval (CI: one sample statistics) are given for those which showed CV > 20%; SD- standard deviation, BMI- body mass index (wt in kg/ht in msq), WHR, waist-to-hip ratio, WHtR- waist-to-height ratio, MUAC-mid upper arm circumference, SBP & DBP- systolic & diastolic blood pressure, FBG- fasting blood glucose, HbA1c- hemoglobin A1c, TG- Triglycerides, HDL- high- density lipoprotein, ACR-urine microalbumin-creatinine ratio.*

Table 2: *Comparison of characteristics between normoglycemic and hyperglycemic (FBG < 5.6 v. ≥ 5.6 mmol/l) subjects*

Characteristics	Normoglycemic (n = 3841)		Hyperglycemic FBG mmol/l(n=300)		*p*
	Mean	SD	Mean	SD	
Age (y)	37.3	15.1	42.2	15.5	.000
BMI	19.4	2.8	19.7	3.3	.063
WHR	0.843	0.067	0.855	0.074	.003
WHtR	0.440	0.050	0.449	0.056	.002
SBP (mmHg)	119	18	123	20	.000
DBP (mmHg)	77	11	79	12	.001
FBG (mmol/l)	4.6	0.5	6.5	2.1	.000

	N	Normo- n	Hyper- n(%)	*P* after χ^2,df=1
Sex				
Men	1749	1623	126 (7.2)	
Women	2392	2218	174 (7.3)	ns
Social class				
Low	3138	2930	206 (6.6)	
High	1003	911	94 (9.2)	ns
Family history of DM				
Unknown	4021	3738	283 (7.3)	
Yes	120	103	17 (14.2)	0.005
Family history of HTN				
Unknown	3762	3494	268 (7.1)	
Yes	379	347	32 (8.4)	ns
Family history of CHD				
Unknown	4003	3709	294 (7.3)	
Yes	138	132	6 (4.3)	Ns
CHD newly detected				
No	4067	3793	274 (6.7)	
Yes	74	48	26 (35.1)	0.001

SD- standard deviation, BMI- body mass index (wt in kg/ht in msq), WHR, waist-to-hip ratio, WHtR- waist-to-height ratio, MUAC- mid upper arm circumference, SBP & DBP- systolic & diastolic blood pressure, FBG- fasting blood glucose, HbA1c- hemoglobin A1c, TG- Triglycerides, HDL- high- density lipoprotein, ACR- urine microalbumin-creatinine ratio.

the hyperglycemic and 20% of the randomly selected normoglycemic subjects (n=768) were undertaken for further investigations like cholesterol, TG, HDL, HbA1c, ACR shown in Table-1b. The characteristics of the hyperglycemic and normoglycemic subjects were compared (Table 2). Compared with the normoglycemic, the hyperglycemic subjects had significantly higher age, WHR, WHtR, SBP, DBP and FBG; whereas, they did not differ with respect to sex, social class, family history of HTN and CHD. In contrast, the family history of diabetes was significantly higher among the hyperglycemic group ($p < 0.01$).

Table-3 shows the comparison of characteristics between subjects with and without CHD. The subjects with CHD had a significantly higher age ($p < 0.001$), WHtR ($p < 0.03$), SBP ($p < 0.01$), DBP ($p < 0.05$), FBG ($p < 0.001$) and ACR ($p < 0.01$) than their non-CHD counterpart; whereas, other characteristics like BMI, WHR, Chol, TG, HDL, LDL, VLDL and lipoprotein (a) did not differ.

The crude prevalence of CHD was 1.8% (m/f = 1.5 / 2.0%) and the age-adjusted (20-69y) prevalence was 1.85% with 95% CI, 1.42 – 2.28 (table not shown). There was no significant difference between men and women. Significantly higher prevalence of CHD was found among subjects of middle and older age group than the younger subjects (<45 v. ≥45y: 5% v. 15%, OR, 3.34 with 95% CI, 2.06 – 5.40) (Table-4). The prevalence of CHD was also higher among subjects with higher SBP (<135 v. ≥135mmHg: OR, 2.14 with

Table 3: *Comparison of characteristics between subjects with and without coronary heart disease (CHD)*

Characteristics	Participants without CHD n = 902		Participants with CHD n = 74		p
	Mean	SD	Mean	SD	
Age (y)	38.1	13.5	47.2	19.1	.000
BMI	19.4	2.9	19.5	2.9	.851
WHR	.845	.069	.858	.075	.135
WHtR	.442	.051	.456	.057	.024
MUAC (cm)	23.8	2.7	23.3	2.5	.108
SBP (mmHg)	120	19	128	29	.001
DBP (mmHg)	77	12	80	15	.039
FBG (mmol/L)*	4.7	0.86	5.5	1.6	.001
OGTT (0h,mmol/L)†	4.3	1.4	4.6	1.5	ns
OGTT (2h,mmol/L)†	6.8	3.0	7.6	3.4	.031
HbA1c (%)	6.0	1.0	6.2	1.2	.041
Total Chol(mg/dl)	126	42	123	41	.602
TG (mg/dl)	112	83	111	65	.884
HDL (mg/dl)	42.9	10.5	42.0	8.7	.502
LDL (mg/dl)	60.7	37.4	59.2	36.8	.731
VLDL (mg/dl)	22.4	16.5	22.1	13.0	.884
Lipoprotein (a)	18.9	15.2	16.1	10.6	.121
ACR	15.3	15.9	20.9	31.5	.009

** - total population vs. CHD (n = 4067 vs. 74);*
SD- standard deviation, BMI- body mass index (wt in kg/ht in msq), WHR, waist-to-hip ratio, WHtR- waist-to-height ratio, MUAC- mid upper arm circumference, SBP & DBP- systolic & diastolic blood pressure, FBG- fasting blood glucose, HbA1c- hemoglobin A1c, TG- Triglycerides, HDL- high- density lipoprotein, ACR- urine microalbumin-creatinine ratio.

95% CI, 1.25 – 3.66). Hyperglycemic subjects showed an excess risk for CHD than their normoglycemic counterparts (8.7 v. 1.2%; OR, 7.5 with 95% CI, 4.58 – 12.73). Significant association of CHD was also found in those participants who had a higher ACR and higher WHtR.

Table 4: *The association of coronary heart disease with some known risk variables (Odds ratio are shown for those variables which found significant following chi sq. test)*

	N	Non-CHD n	CHD n(%)	*P* after χ^2,df=1	OR	95%CI
Age (y)						
<45	731	694	37 (5.1)			
≥45	245	208	37(15.1)	<0.001	3.34	2.06–5.40
Sex						
Men	394	368	26 (6.6)			
Women	582	534	48 (8.2)	ns		
BMI						
<23	745	691	54 (7.2)			
≥23	231	211	20 (8.7)	ns		
WHR						
<0.89	737	682	55 (7.5)			
≥0.89	239	220	19 (7.9)	ns		
WHtR						
<0.55	724	678	46 (6.4)			
≥0.55	252	224	28(11.1)	0.012	1.84	1.13–3.02
MUAC (cm)						
<23.0	604	553	51 (8.4)			
≥23.0	368	345	23 (6.3)	ns		
SBP (mmHg)						
<135	814	761	53 (6.5)			
≥135	162	141	21 (13.0)	0.006	2.14	1.25–3.66
DBP (mmHg)						
<85	782	731	51 (6.5)			
≥85	194	171	23 (11.9)	0.012	1.93	1.15–3.24
FB (mmol/L)						
<5.6	3841	3793	48 (1.2)			
≥5.6	300	274	26 (8.7)	0.001	7.49	4.58–12.73
HbA1c (%)						
<6.4	732	683	49 (6.7)			
≥6.4	239	214	25 (10.5)	0.042	1.63	0.98–2.70
ACR						
<17.2	795	744	51 (6.4)			
≥17.2	180	157	23 (12.8)	0.004	2.14	1.27–3.60

OR- odds ratio, CI- confidence interval, BMI- body mass index (wt in kg/ht in msq), WHR, waist-to-hip ratio, WHtR- waist-to-height ratio, MUAC-mid upper arm circumference, SBP & DBP- systolic & diastolic blood pressure, FBG- fasting blood glucose, HbA1c-hemoglobin A1c, TG- Triglycerides, HDL- high- density lipoprotein, ACR-urine microalbumin-creatinine ratio.

Table 5: *Logistic regression taking CHD as the dependent variable*

Independent risk variables	Sig.	OR	95.0%C.I.
Age (y) tertile	.000		
Tertile- I (age <28)	.654	1.21	0.52–2.83
Tertile- II (age 28 – 40)	.799	1.13	0.45–2.79
Tertile- III (age >40)	.001	3.80	1.72–8.42
Family income (cut-off 75th percentile)	.176	0.66	0.37–1.20
Sex	.237	0.72	0.42–1.24
OGTT 2h (<7.0=1,≥7.0=2)	.013	1.90	1.15–3.16
DBP (mmHg ≤85=1, >85=2)	.904	1.04	0.57–1.88
Family history of HTN	.132	1.69	0.85–3.36
Family history of CHD	.005	4.36	1.56–12.22
ACR (≤17.2 =1, >17.2=2)	.011	2.03	1.17–3.51
Constant	.000	0.06	-

We also estimated the association of CHD with family income, education, occupation and smoking habits. None of these variables showed any significant association with CHD. In contrast, family history of hypertension and family history of CHD proved to have a significant risk for CHD.

Finally, the risk factors were quantified by logistic regression analysis (Table-5). Adjusted for sex and social class, age over 45 years (OR, 3.8, 95% CI, 1.72 – 8.40), FBG 5.6 mmol/l or more (OR, 3.8, 95% CI, 1.72 – 8.40), ACR 17.2 or more (OR, 2.0, 95% CI, 1.17 – 3.51) and family history of CHD (OR, 4.4, 95% CI, 1.56 – 12.22) proved to have an excess risk for CHD. The other known risk factors like higher BMI and WHR and dyslipidemia (high cholesterol or TG or LDL and low HDL) and smoking habits were found not significant for CHD in this study population.

Discussion

The study is rather new in Bangladesh and it is also quite unique in the sense that it is a population based study taking a background population of 11,895 in the rural communities. Very few published reports have such a rural background population. We used Google search engine, Bangladesh Medical Journal online (Banglajol), pub-med and World Health Organization Statistical Information System (WHOSIS) for a comparison with our findings. We could not retrieve any information on the prevalence of CHD in Bangladeshi native population though some are available on Bangladeshi immigrants in UK.[14,15] Two

studies on CHD were reported in Bangladesh. Both addressed not the prevalence but the risk of CHD conducted in a tertiary hospital.[16,17]

Additional merit of the study is that more than 90% of the selected participants volunteered for ECG, OGTT, t-cholesterol, TG, HDL, LDL and ACR in a rural setting.

The prevalence of CHD found in this study is consistent with the studies conducted in rural and in northern Indian population.[18] Several Indian studies reported the prevalence of CHD ranging from 4 to 12% among the Indian adult population,[19-21] which is more than double the prevalence we have. The higher prevalence in India may be due to the higher age group, urban population and the studies being more recent. In contrast, this study included younger subjects (20-29y), rural communities and the time period being 2002 – 2003. If we carry out similar prevalence study at present and exclude the younger age then the difference would probably be much less. Again, if we consider the prevalence of CHD in Chinese and Japanese population then the Bangladeshi study population has a higher prevalence of CHD.[23]

As regards risk factors for CHD, advancing age, diabetes, hypertension, family history of CHD and high ACR are very consistent with other studies.[14-16,18-20] Interestingly, smoking habit, general obesity (high BMI), central obesity (high WHR), dyslipidemia (high chol, TG, low HDL) and extremes of social class (affluent or socially deprived) were found not significantly related to CHD. Why these known risk factors are not related to CHD in the study population is not clear. Possibly, the study population was neither obese (mean BMI $\pm$ SD: 19.4 $\pm$ 2.9; WHR: 0.84 $\pm$ 0.07) nor dyslipidemic (95% CI: cholesterol, 121 -129, TG, 105 – 117) and not exceeding the thresholds of obesity or dyslipidemia for developing CHD. Consequently, these risk factors were found not contributing to atherosclerosis.

The other explanation may be that we had investigated a small number of people and failed to reach the level of significance. Had we investigated a larger sample we could have related these risk factors to CHD. It may also happen that some other risk factors interacting in the genesis of CHD in the rural environment is yet to be explored. It may be noteworthy to mention that it was difficult to standardize the history of smoking habits. There were so many types of smoking agents and smoking behavior in the rural communities (cigarettes with and without filter, bidi, hukka; recent / past / occasional; number of sticks / number of puffs / age when started / duration of smoking) that needed standardization and we failed to standardize. Thus, analysis of smoking might have errors to relate smoking to CHD. There are other limitations of the study. We did not include two important risk variables – physical activities and dietary habits. Had we included these two risk factors we could have chance to quantify the individual (or confounding) contributions of the investigated risk variables.

Conclusions

The study concludes that the prevalence of CHD is almost comparable with the Indians and even higher than Japanese and Chinese. Family history of CHD and age over 45 years, and who had hyperglycemia and higher ACR were observed to be the independent predictors of CHD. CHD was found to affect participants irrespective of sex, social class, obesity and lipid status. Although the IFG and diabetes groups appeared to have similar biophysical characteristics, only the diabetes group had a significant risk for CHD. Further studies on a larger sample may be undertaken to confirm the study findings and to explore some unidentified risk factors of CHD.

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