Original Article

Rural-Urban Epidemiologic Transition of Risk Factors for Coronary Artery Disease in College Students of Hyderabad and Nearby Rural Area – A Pilot Study

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Abstract

Objectives: Massive urbanization in developing nations like India is predicted to cause epidemiologic transition to increased Coronary Artery Disease (CAD). To evaluate the rural-urban epidemiologic transition, risk factors for CAD were measured in two groups of subjects; Rural and Urban college students.

Methods: Subjects included 232 college students (58 men and 58 women in each group) aged between 18-22 years (mean 19.2 ±1.0). Since the age of urban youth was significantly higher (19.9 vs 18.4 years), age-adjusted analysis was performed.

Results: Age-adjusted BMI was significantly higher in urban (21.8 vs 17.8); 69.8% of rural and 13.8% of urban were underweight whereas 3.5% of rural and 31.9% of urban were either overweight or obese. Waist circumference (73.2 vs 61.9 cm), waist: hip circumference ratio (0.80 vs 0.75), diastolic BP (72.7 vs 67.9 mmHg), fasting blood glucose (82.4 vs 79.0 mg/dl), total cholesterol (147.9 vs 129.2 mg/dl), and LDL (89.3 vs 71.9 mg/dl) were significantly higher in the urban group. Triglycerides (79.1 vs 76.5 mg/dl), VLDL (15.9 vs 15.2 mg/dl) and systolic BP (114 vs 115 mmHg) were not significantly different. HDL (43.3 vs 40.7 mg/dl) and Cholesterol/HDL ratio (3.5 vs 3.3) were higher in urban group but with borderline significance (p=0.057and 0.056 respectively).

Conclusion: Epidemiologic transition to higher risk for CAD is found in urban youth of Hyderabad compared to nearby villages, with increases in values of most parameters which are associated with increased risk for CAD. These findings need to be confirmed in extended studies to plan public health interventions to counteract the adverse effects of urbanization in early life.

Introduction

It is estimated that the burden due to cardiovascular disease (CVD) will markedly increase in developing countries particularly in the Indian subcontinent. In 2003, the prevalence of coronary Artery Disease (CAD) in Indian adults was estimated to be 3-4 percent in rural areas and 8-20 percent in urban areas.[1-5]. Rapid economic progress in India is causing massive urbanization. Urbanization is characterized by marked increase in intake of calories. This may lead to obesity, hypertension, hyperglycemia and hypercholesterolemia - a deadly combination of risk factors for CAD.

The epidemiologic transition to increased CAD associated with urbanization is not fully studied. Urbanization may induce negative changes in lifestyle. An understanding of the changes in youth may help to plan strategies effective early to prevent the CAD in Indian subcontinent. There are few studies related to cardiac risk factors in young urban Asian Indians but almost none in rural youth.[6-9] Therefore, we have undertaken a study of CAD risk factors in urban and rural youth to understand the trends in the epidemiologic transition in this group.

Methodology

The study was approved by the institution ethics committee. An informed consent was obtained from all participants. The Urban youth constituted medical students living within the municipal limits (625 sq km) of Hyderabad with a population of approximately 9 million, studying at the MediCiti Institute of Medical Sciences, located in suburban Hyderabad. Rural youth constituted the students living in one of the 41 villages of Medchal Mandal (47 sq km), near Hyderabad, with a rural population of approximately 46,000 and studying in the local Government College.

One hundred and sixteen urban and 116 rural apparently healthy students aged 18-22 were recruited for the study. There were equal numbers of men and women in each group. Only those medical students who have been living in the urban area for more than 5 years were included in the study. Each class of medical students was addressed and the protocol was explained. Volunteers willing to participate were invited. No volunteers were excluded for health or other reasons. At the Government College the protocol was explained, similarly, to all the students. Informed consent was obtained individually from each student who volunteered to participate in the study. Volunteers were enrolled in the study until the desired sample size was reached for each gender in each group. In the Medical College the measurements were made in a research suite and at the Government College studies were made in a class room which was temporarily modified for the purpose. Measurements were made by the investigators specially trained by experienced career researchers of National Institute of Nutrition, Hyderabad, India.

Information about socioeconomic status, smoking, alcohol intake and amount of physical activity was obtained using a standardized questionnaire. Height (Ht), weight (Wt), waist (W)

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and hip (H) circumferences were measured by a standardized protocol, using criteria of the INTERHEART study.[10] Hip and waist circumferences were measured using a fiberglass measuring tape. Waist girth was measured around the narrowest point between ribs and hips (unclothed abdomen). Widest diameter of the buttocks was measured over light clothing as hip circumference. BMI was calculated by using the formula: BMI = Wt in Kg/ Ht in meter.[2] Blood pressure was measured using automated oscillometric sphygmomanometer (Omron model Hem NO.712c.).[11] Two readings at five minute intervals were measured and the average of two recorded.[12] After 12 hrs of fasting, 5 ml of blood was taken and analyzed for Total Cholesterol (TC), High Density lipoproteins (HDL), Triglycerides (TG) and plasma Glucose (GL) by kit method using Dade-Behring expanded plus auto-analyzer. Low-density lipoprotein (LDL) cholesterol concentrations were estimated using the Friedewald formula.[13] The INTERHEART study criteria were used for smoking, exercise and consumption of alcohol. Individuals were considered to be physically active if they were regularly involved in moderate exercise (walking, cycling or gardening) or strenuous exercise (jogging, or vigorous swimming, playing cricket or foot ball) for 4 or more hours a week. Regular alcohol use was defined as consumption of three or more drinks a week. Cut off points for abnormal values for risk factors are defined in Table 1.

Statistical analysis was done using STATA 9.2 version.[17] Unpaired T test or Pearson's Chi-squared test was used wherever appropriate. Age adjusted means were calculated, and significance tested, using analysis of variance.

Results

Age: Although 18-22 year old subjects were consecutively selected until the target number was reached, the urban youth were one to two years older than the rural youth (Table 2). Therefore, we calculated the study variables both without and with adjustment for age (Table 2 & 3).

Height (Ht), weight (Wt), BMI: Age-adjusted Ht was significantly higher in urban males compared with rural males, 7 cm difference. This difference was not seen in women (Table 3). There was a striking difference ($p< 0.001$) in mean weight between urban and rural students; 62.4 vs 49.9 kg in urban vs rural males, respectively; 52.9 vs 41.7 kg in urban vs rural females, respectively. BMI was also significantly higher in both urban men and women (Table 3). Seventy percent of rural youth were underweight (72.4% of females and 67.2% of males) compared to 13.8% in urban males and females; whereas 3.5 % of rural youth and 31.9% of urban youth were more than normal weight (Table 4). Thus there was a five fold lower proportion of underweight and almost 10 fold higher proportion of overweight (including obese) in the urban youth compared to the rural youth.

Waist Circumference (W): W was considerably larger in both male (14.5 cm difference) and female (7.8 cm difference) urban subjects (Table 3). W was abnormal in 6.9% urban and 0.9% rural youth (Table 5).

Hip Circumference (H): Among the urban youth, both men and women, had significantly larger hip circumference (9.6 and 7.4 cm larger, respectively) than the rural youth (Table 3).

Waist: Hip (W: H) Ratio: Both men and women urban subjects had significantly higher W: H ratio (Table3).

Blood pressure: Systolic and diastolic blood pressures were significantly higher in the urban men, but not women (Table 3). The prevalence of hypertension was not significantly different in the urban group (Table 5).

HDL-cholesterol (HDL): HDL was higher in the urban women. However, the trend was borderline significant when adjusted for the age (Table 3). Abnormally low HDL was present in a large proportion of subjects: rural subjects 59.5% (85% F and 35.6% M) and Urban subjects 56.9% (79.3% F and 34.5% M) (Table 5).

Total cholesterol/HDL ratio (TC/HDL): Compared to the rural youth the TC/HDL ratio was significantly higher in the urban men but not in the urban women (Table 3).

Glucose (GL): Fasting glucose was significantly higher in the urban men and borderline higher in urban women (Table 3).

Physical activity, smoking and alcohol consumption: A significantly lower proportion of urban females were found to be physically active compared with rural females. The proportion physically active was the same in urban compared with rural males (Table 5). Smoking was very infrequent, seen in only two rural and 4 urban males. Regular intake of alcohol was not reported by any individual, either rural or urban origin. Occasional drinking was noted in six rural and 8 urban males.

Metabolic syndrome: None of the urban or rural participants were categorized as positive for metabolic syndrome based on the criteria in Table 1.

Discussion

Economic progress and Industrialization is inevitable in south Asia. If so, increase in the burden of disease due to CAD appears to be equally inevitable. Instead of waiting for the epidemic to occur and then respond by corrective measures, it may be prudent to identify the onset of epidemiologic transition of risk factors to higher risk for CAD and take appropriate measures to prevent the aggravation of risk factors and contain the epidemic. The current study suggests that the onset of transition of various risk factors to higher risk for CAD with urbanization may be taking place at an early age.

Markers of obesity (BMI, waist and hip circumference, and W: H ratio) were consistently higher in urban youth compared with rural youth. The ten fold increase in the prevalence of overweight (including obesity) in urban youth (31.9% vs 3.5%) is of particular concern. The reduced level of activity observed in urban females likely contributes to the prevalence of overweight and obesity, but surprisingly, reported physical activity levels were similar in urban and rural males.

Other CAD risk factors, including total cholesterol, LDL, fasting blood sugar and diastolic blood pressure (but not systolic) were significantly higher in urban youth, particularly in males. HDL was not lower in urban youth, and if any it was marginally increased in urban women despite lower levels of physical activity. In the past, this was also noticed in a Northern Indian study[18] and recently by Snehalatha et al in a Southern Indian study[19] with the mean age of 34.0±11.5 (city), 34.4±10.6 (town) and 37.6±11.6 (villages). We agree with the latter's suggestion that the higher HDL in urban participants may be secondary to overall rise in cholesterol, which may be secondary to increased consumption of calories as evidenced by marked decrease in prevalence of underweight in urban youth. However, recent studies have shown that TC: HDL ratio to be the strongest predictor of CAD mortality and much more informative than total cholesterol and HDL cholesterol.[20] It is also found to be as good as ApoB/ApoA1 ratio.[21] TC/HDL ratio was increased in urban men compared to rural men but not women, indicating

Table 1: Defining levels for risk factors

Risk factor	Defining level	Source
Waist circumference(W)	Male (M) ≥ 90 cm Female (F) ≥ 80 cm	*IDF Asian specific[14]
Waist: Hip circumference(H) ratio (W:H)	M ≥0. 90, F ≥0. 83	Interheart study[10]
BMI (kg/m^2)	≥23	WHO[15]
Glucose (GL)	≥100 mg/dl	IDF[14]
Triglycerides(TG)	≥150 mg/dl	ATPIII[16]
Total Cholesterol (TC)	≥200 mg/dl	ATPIII[16]
High density lipoprotein(HDL)	M < 40mg/dl, F < 50mg/dl	ATPIII[16]
Hypertension(HTN)	≥130 / 85 mm Hg	ATPIII[16]
Metabolic Syndrome(MS)	presence of at least three of the abnormalities: W,TG,HDL,HTN,GL	ATPIII[16]

*IDF=International Diabetes Federation

Table 2: Characteristics of Rural and Urban subjects

Mean (SE)		Female	Male	Total
AGE yrs	Rural (SE)	18.1 (0.04)	18.7 (0.12)	18.4 (0.07)
	Urban (SE)	20.0 (0.15)**	19.8 (0.18)**	19.9 (0.12)**
Height (Ht) cm	Rural (SE)	151.6 (0.65)	161.4 (1.40)	156.7 (0.90)
	Urban (SE)	155.4 (1.95)	168.1 (1.01)*	161.8 (1.24)**
Weight (Wt) kg	Rural (SE)	40.9 (0.74)	50.4 (1.95)	45.8 (1.13)
	Urban (SE)	53.7 (1.03)**	61.8 (1.62)**	57.8 (1.03)**
BMI (kg/m^2)	Rural (SE)	17.7 (0.35)	18 (0.30)	17.9 (0.22)
	Urban (SE)	21.9 (0.39)**	21.7 (0.43)**	21.8 (0.28)**
Waist Circumference (W) cm	Rural (SE)	59.8 (0.76)	63.7 (0.88)	61.9 (0.60)
	Urban (SE)	68.5 (0.73)**	78.1 (1.09)**	73.3 (0.07)**
Hip (H) cm	Rural (SE)	81.7(0.69)	81.9 (0.68)	81.7 (0.49)
	Urban (SE)	91.3 (0.84)**	91.2 (1.10)**	91.3 (0.68)**
Waist: hip ratio (W:H)	Rural(SE)	0.74 (0.01)	0.77 (0.01)	0.76 (0.05)
	Urban (SE)	0.75 (0.01)	0.85 (0.01)**	0.80 (0.01)**
Systolic BP (SBP) mm Hg	Rural (SE)	113.0 (1.39)	117.5 (1.40)	115.1 (1.00)
	Urban (SE)	108.0 (1.09)	119.5 (1.53)	113.8 (1.08)
Diastolic BP (DBP) mm Hg	Rural (SE)	69.3 (1.10)	67.5 (1.25)	68.3 (0.83)
	Urban (SE)	71.6 (0.93)	72.8 (0.92)*	72.2 (0.68)**
Glucose (GL) mg/dL	Rural (SE)	78.0 (0.99)	79.9(1.18)	79.0 (0.77)
	Urban (SE)	82.0 (0.89)*	82.6 (0.81)	82.4 (0.60)*
Triglycerides (TG) mg/dL	Rural (SE)	67.1 (3.42)	92.6 (4.12)	80.1 (2.92)
	Urban (SE)	69.9 (3.86)	81.2 (4.53)	75.5 (3.01)
Total cholesterol (TC) mg/dL	Rural (SE)	138.0(3.67)	121.2(2.87)	129.5 (2.45)
	Urban (SE)	149.2 (3.75)	146.0 (4.27)**	147.6 (2.83)**
LDL mg/dL	Rural (SE)	81.6 (3.28)	62.5(2.74)	71.9 (2.30)
	Urban (SE)	89.7 (3.70)	88.8 (4.06)**	89.3 (2.74)**
VLDL mg/dL	Rural (SE)	13.3(0.67)	18.7 (0.81)	16.0 (0.58)
	Urban (SE)	13.8 (0.78)	16.3 (0.91)	15.1(0.61)
HDL mg/dL	Rural (SE)	41.4 (1.10)	40.1 (0.74)	40.7 (0.66)
	Urban (SE)	45.6 (1.55)*	41.0 (0.67)	43.3 (0.86)*
TC:HDL ratio	Rural (SE)	3.4 (0.09)	3.1 (0.09)	3.2 (0.07)
	Urban (SE)	3.4 (0.12)	3.6 (0.12)**	3.6 (0.09)*

Urban vs Rural * $p< 0.05$, ** $p< 0.001$

epidemiologic transition to higher risk in men. Thus the seeds for increased risk for CAD, with quantitative increases in many known risk factors seem to be sown at an early age, particularly in males. These trends have to be confirmed in a larger sample, and also in younger age groups and followed into adulthood to formulate policies for primary prevention. Rapid escalation of these risk factors by age of 30–39 years and by age of 25-34 years in urban Asian Indians was noted by Gupta et al[6] and Kaur et al[9] respectively. Quantitative differences in certain risk factors in urban youth between Gupta, Kaur and our study can be partly explained by the differences in sampling and age of subjects selected for each study. Although risk factors are more favorable in the rural youth, the shorter stature and the high rate of underweight among the rural youth suggest that the optimal lifestyle is somewhere in between the experience of the rural and urban children; it is likely that childhood caloric intake should generally be increased among rural children, and decreased among urban children.

Metabolic syndrome as defined by NCEP ATP III was absent in all our subjects- rural as well as urban. However, our study found prevalence of low HDL to be very high -85% and 79.3% of rural and urban women and 35.6% of rural and 34.5% of urban men. Our study is consistent with previous observations of INTERHEART study involving south Asians[22] and other Indian studies[23, 24] revealing high prevalence of low HDL levels, as per NCEP ATP III criteria. In a large study in Northern India, Gupta[23] found low HDL in 90% of the women and 55% of men aged 20 and above. Such a high prevalence of low HDL in rural youth as well as urban adults begs the question- genetic predisposition for a risk factor or wrong cutoff points? and needs further investigation.

We found relatively low triglyceride levels without increase in urban youth. In a large study of adults Snehalatha et al[19] observed no change in triglyceride levels between the non diabetic inhabitants of a village and a city of Southern India. In a recent study of Asian Indians in USA,[25] compared to other ethnic groups, Indians were shown to have the highest prevalence of high blood sugar and hypertriglyceridemia. In the same study it was found that triglyceride levels progressively increased from normal individuals to impaired glucose tolerance group to diabetic subjects in parallel with progressively increasing fasting blood sugars. Elevated triglyceride levels contributing to the increased prevalence of Metabolic syndrome in South Asians seems to be secondary to glucose intolerance and diabetes, which itself may be a result of insulin resistance.[26]

Our investigation is unique in studying the rural-urban transition of cardiac risk factors in Indians at an early age. The study is limited by relatively small sample size of college students of Hyderabad and nearby rural area and convenience sampling. The results cannot be generalized and should be interpreted with caution. It constitutes a pilot study for more extensive and comprehensive studies.

In conclusion, epidemiologic transition to higher risk for CAD is found in urban youth with increases in values of most parameters whose quantitative increases are associated with increased risk for CAD. Compared to rural subjects, tendency for higher levels of HDL particularly in urban women and relatively low levels of HDL in both rural and urban subjects needs to be further studied.

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Table 3: Age-Adjusted Characteristics of Rural and Urban subjects

Mean (SE) p		Female	Male	Total
Height (Ht) cm	Rural	154.4 (1.8)	161.5 (1.3)	157.6 (1.2)
	Urban	152.6 (1.8)	168.2**(1.3)	160.8 (1.2)
p		0.55	0.001	0.091
Weight (Wt) kg	Rural	41.7 (1.1)	49.9 (1.9)	45.8 (1.2)
	Urban	52.9** (1.1)	62.4**(1.9)	57.7**(1.2)
p		0.001	0.001	0.001
BMI (kg/m²)	Rural	17.8 (0.5)	17.9(0.4)	17.8 (0.3)
	Urban	21.7** (0.47)	21.8**(0.39)	21.8**(0.3)
p		0.001	0.001	0.001
Waist Circumference (W) cm	Rural	60.3 (1.0)	63.7 (1.1)	61.9 (0.8)
	Urban	68.1** (1.0)	78.2 **(1.1)	73.2**(0.8)
p		0.001	0.001	0.001
Hip cm	Rural	82.8 (1.0)	81.7 (1.0)	82.0 (0.7)
	Urban	90.2** (1.0)	91.3**(1.0)	91.0**(0.7)
p		0.001	0.001	0.001
W:H ratio	Rural	0.73 (0.008)	0.77 (0.007)	0.75 (0.006)
	Urban	0.75 *(0.008)	0.84**(0.007)	0.80**(0.006)
p		0.041	0.001	0.001
Systolic BP (SBP) mm Hg	Rural	112.9 (1.6)	116.0 (1.5)	114.0 (1.2)
	Urban	108.1 (1.6)	121.1*(1.5)	115.0 (1.2)
p		0.07	0.024	0.55
Diastolic BP (DBP) mm Hg	Rural	70.0 (1.3)	66.8 (1.2)	67.9 (0.9)
	Urban	70.9 (1.3)	73.5**(1.2)	72.7**(0.9)
p		0.67	0.001	0.001
Glucose (GL) mg/dL	Rural	78.5 (1.3)	79.5 (1.0)	79.0(0.8)
	Urban	82.3 (1.3)	82.5*(1.0)	82.4*(0.8)
p		0.08	0.045	0.01
Triglycerides (TG) mg/dL	Rural	69.2 (4.6)	89.8(4.5)	79.1(3.3)
	Urban	67.8 (4.6)	84.5(4.5)	76.5(3.3)
p		0.85	0.44	0.61
Total cholesterol (TC) mg/dL	Rural	142.7 (4.7)	120.2 (3.9)	129.2 (3.0)
	Urban	145.2 (4.7)	146.7**(3.9)	147.9**(3.0)
p		0.70	0.001	0.001
LDL mg/dL	Rural	85.7 (4.4)	62.0 (3.7)	71.9 (2.9)
	Urban	85.8 (4.4)	88.9**(3.7)	89.3**(2.9)
p		0.99	0.001	0.001
VLDL mg/dL	Rural	13.9 (0.9)	18.0 (0.9)	15.9 (0.7)
	Urban	13.3 (0.9)	17.0 (0.9)	15.2 (0.7)
p		0.69	0.44	0.56
HDL mg/dL	Rural	41.0 (1.7)	40.2 (0.8)	40.7 (0.9)
	Urban	46.0 (1.7)	40.8 (0.8)	43.3 (0.9)
p		0.079	0.56	0.057
TC/HDL ratio	Rural	3.5(0.1)	3.1(0.1)	3.3 (0.1)
	Urban	3.3 (0.1)	3.6(0.1)*	3.5 (0.1)
p		0.26	0.002	0.056

Urban vs Rural * $p<0.05$, ** $p<0.001$

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Table 4: Prevalence of BMI categories

No. (%)	Under-weight <18. 5	Normal weight ≥18. 5 <23	Overweight ≥23 <25	Obese ≥25	Overweight + Obese
Rural Total	81(69.8)	31 (26.7)	1 (0.9)	3 (2.6)	4 (3.5)
Rural Female	42 (72.4)	14 (24.7)	1 (1.7)	1 (1.7)	2 (3.5)
Rural male	39 (67.2)	17 (29.3)	0 (0)	2 (3.5)	2 (3.5)
Urban total	16 (13.8)	63 (54.3)	17 (14.7)	20 (17.2)	37 (31.9)
Urban Female	8 (13.8)	28 (48.2)	11 (19.0)	11 (19.0)	22 (38.0)
Urban Male	8 (13.8)	35 (60.0)	6 (10.3)	9 (15.5)	15 (25.8)

Table 5: Prevalence of risk factors

Risk factor No. (%)		Female	Male	Total
BMI	Rural (n = 58)	2 (3.5)	2 (3.5)	4 (3.5)
	Urban (n=58)	22 (37.9)**	15 (25.9)**	37 (31.9)**
W	Rural (n = 58)	0 (0)	1 (1.7)	1 (0.9)
	Urban (n=58)	2 (3.5)	6 (10.3)*	8 (6.9)*
W:H	Rural (n = 58)	6 (10.3)	1 (1.7)	7 (6.0)
	Urban (n=58)	6 (10.3)	11 (19.0)**	18 (15.5)
HTN	Rural (n = 58)	6 (10.3)	9 (15.8)	15 (12.9)
	Urban (n=58)	2 (3.5)	16 (27.6)	18 (15.5)
GL	Rural (n = 58)	1 (1.7)	1 (1.7)	2 (1.7)
	Urban (n=58)	0 (0)	0 (0)	0 (0)
TC	Rural (n = 58)	1 (1.7)	0 (0)	1 (0.9)
	Urban (n=58)	4 (6.9)	3 (5.2)	7 (6)*
LDL	Rural (n = 58)	1 (1.7)	0 (0)	1 (0.9)
	Urban (n=58)	4 (6.9)	4 (6.9)*	8 (6.9)*
HDL	Rural (n = 58)	49 (85.0)	21 (35.6)	69 (59.5)
	Urban (n=58)	46 (79.3)	20 (34.5)	66 (56.9)
Physically active[a]	Rural (n = 58)	33 (56.9)	25 (43.1)	58 (50.0)
	Urban (n=58)	16 (27.6)*	26 (44.8)	42 (36.2)

*$p<0.05$, **$p<0.001$; See Table 1 for risk factor criteria; [a] See methods for definition.

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