Identification of Coronary Risk Factors Among Urban and Rural Malaysian Youths and Their Possible Underlying Causes

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Abstract

Background: Coronary artery disease (CAD) is one of the major causes of morbidity and mortality worldwide. Early identification of the coronary risk factors (CRF) among youths assists in determining the high-risk group to develop CAD in later life. In view of the modernised lifestyle, both urban and rural residing youths are thought to be equally exposed to various CRF. This study aimed to describe the common CRF including obesity, dyslipidaemia, hypertension, smoking and family history of premature CAD in Malaysian youths residing in urban and rural areas.

Methods: We recruited 942 Malaysian subjects aged 15–24 years old [(males=257, and urban=555 vs rural=387, (mean age ± SD = 20.5 ± 2.1 years)] from the community health screening programmes organised in both rural and urban regions throughout Malaysia. Medical history and standardised anthropometric measurements were recorded. Laboratory investigations were obtained for fasting serum lipid profiles and plasma glucose levels.

Results: Youths in the rural were more overweight and obese (49.4% vs 42.7%, $p<0.044$) and have higher family history of hyperlipidaemia (16.3% vs 11.3%, $p<0.036$) than youths in the urban areas. Low-density lipoprotein (LDL-c) (2.8 vs 2.7 mmol/L) and total cholesterol (TC) (4.7 vs 4.5 mmol/L) were significantly higher in urban compared to rural youths ($p<0.019$ and $p<0.012$). Overall, more youth in this study has CRF rather than not (Has CRF = 67.0% vs No CRF = 33.0%). Significantly more rural youths have at least one CRF compared to urban youths (rural = 71.6% vs urban = 63.8%, p=0.012).

Conclusion: In conclusion, rural youths have significantly higher BMI with higher family history of hyperlipidaemia compared to urban youths. However, urban youths have higher LDL-c and TC levels. Other coronary risk factors are not significantly different between urban and rural youths. CRF were significantly more prevalent among rural compared to urban youths.

Background

Coronary artery disease (CAD) is one of the major causes of morbidity and mortality worldwide. The World Health Organization (WHO) reported that an estimated 17.9 million people died from cardiovascular disease (CVD) in 2016 and of these deaths, 85% are due to CAD and stroke[1]. Majority of the deaths took place in low- and middle-income countries[1]. CAD had become a burden for the developing nations to date despite increase effort towards its prevention and treatment. In Malaysia, as one of the middle-income countries, CAD is the most common cause of deaths accounting for 98.9 deaths per 100,000 population in 2012, or 29,400 deaths (20.1% of all deaths)[2, 3].

Worryingly, there is a rapid emergence of increasing trend among younger Malaysians to present with CAD. Hoo et al reported that 6.1% of patients with Acute Coronary Syndrome (ACS) were less than 45 years of age with the mean age of young ACS in their study was 39 ± 6 years[4]. The trend is consistent with other nearby South East Asian countries[5]. A study which retrospectively analysed 10,268 patients who underwent percutaneous coronary intervention in Malaysia reported a prevalence of young CAD of 16% (young was defined as less than 45 years for men and less than 55 years for women)[6].

There are multiple risk factors that are associated with progression of early CAD for instance hypertension, obesity, diabetes mellitus (DM), dyslipidaemia, physical inactivity and smoking[7–9]. In view of the recent trend of early CAD, prompt and early identification of the coronary risk factors (CRF) among adolescents and youths is vital to assist in determining the high-risk group to develop CAD in later life. Urbanization in recent years may cause both urban and rural residing youths to be equally at risk of CVD. To date, there are very limited data reporting CRF in adolescents and youth population in this region. Furthermore, the difference of CRF between urban & rural Malaysian residents in this group is still not well documented. Hence, this study aimed to compare the CRF between the Malaysian urban and rural youths between the ages of 15 to 24 years.

Methods

Subjects and design of the study

This was a cross-sectional study involving a total of 5448 Malaysian subjects from the community health screening programmes organised in both rural and urban regions throughout all states in Malaysia. Following this, a total of 942 youths aged 15–24 years old (mean age $\pm$ SD = 20.5 $\pm$ 2.1 years) were included into the analyses. Figure 1 illustrated the map showing the screening sites and the number of participants included in this study. Youth were defined as any individual in an age cohort between 15 and 24 years[10]. Subsequently, a total of 555 subjects were divided into urban group while 387 subjects into rural group.

The study was performed in accordance with the Declaration of Helsinki. All patients and parents gave their written informed consent. The approval from the Institutional Research Ethics Committee [reference code: 600-RMI (5/1/6/01)] was obtained before the commencement of the study. All participants completed a questionnaire which recorded the socio-demography, lifestyle, family history of premature CAD and hypercholesterolaemia.

Anthropometry

All subjects were measured for their height, weight, body mass index (BMI), waist circumference, and blood pressure (BP) by trained professionals. Height and weight were measured to the nearest 0.1 cm and 0.1 kg respectively using a pre-calibrated freestanding mounted to scales stadiometer (Seca, Hamburg, Germany) and height rod in light clothing and without shoes on. WC was obtained using a measuring tape midway between the inferior margin of the rib and the topmost palpable border of the iliac crest with measurements taken to the nearest 0.5cm.

BMI (kg/m^2) was calculated as weight (kg) divided by squared height (m^2). Obesity is defined as BMI $\geq$ 27.5 kg/m^2 and overweight is defined as BMI $\geq$ 23.0 kg/m^2 [11]. On the other hand, Centers for Diseases Control and Prevention (CDC) BMI-to-age gender-specific percentile charts were used for subject aged 15 to 18 years old. For these population, overweight was defined as BMI equal or more than 85th percentile while obese was defined as BMI equal or more than 95th percentile[12]. An automated BP monitor (Omron, USA) was used to measure BP. The cuff was applied on the right arm held at heart level with the participants in seated position following at least 5-minute rest. Three measurements were taken and the average of the last two readings were taken as the participant's BP for the study. Elevated BP is defined as elevated BP with systolic BP (SBP) $\geq$130 mmHg and/or diastolic BP (DBP) $\geq$ 85 mmHg. On the other hand, for adolescents ages 15 to 17 years old, the systolic and diastolic hypertension were defined based on National Heart, Lung, and Blood Institute (NHLBI) guidelines for blood pressure in children and adolescent adapted from The Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescent. Hypertension is defined as average SBP and/or diastolic BP (DBP) that is $\geq$ 95th percentile for gender, age, and height[13].

Personal and family history of diabetes, hypertension, hypercholesterolemia and premature CAD with their medication intake were collected using a standardised health screening data collection sheet. Smoking status and alcohol consumption were documented. Positive family history of premature CAD was defined as history of myocardial infarction, ischaemic heart disease or sudden death at the age of <55 years in males and <65 in females in first-degree relatives.

Subject with secondary hypercholesterolemia, acute inflammation, previous/current history of renal, liver, endocrine disease, morbid obesity (BMI>35.0), patients on long term anti-inflammatory agents, chronic inflammatory disorders, life span-reducing disease including malignancy are excluded from the study.

Biochemical analyses

Fasting venous blood sample were collected into 5 mL of EDTA, serum and fluoride blood tubes after an overnight fast of at least 8 hours. The serum and plasma were separated from blood samples within 2 hours of collection by centrifugation at 1,645 *g* for 7 minutes. The plasma were assayed for fasting plasma glucose (FPG) and serum were assayed for fasting serum lipid which consisted of total cholesterol (TC), triglycerides (TG), and high-density lipoprotein (HDL-c) using the hexokinase and enzymatic reference method respectively on an automated analyser (Cobas Integra 400 plus, Roche Systems, Germany). The Friedewald equation was used to determine low-density lipoprotein cholesterol (LDL-c) concentration. The intra- and inter-assay coefficient of variation (CV) for FPG, TC, TG and HDL were 1.8% and 2.1%; 0.5% and 1.9%; 1.6% and 1.9%; and 1.1% and 1.0%, respectively.

Statistical analysis

All statistical analysis was performed using Statistical Program for Social Science Software (SPSS) version 23.0 (SPSS Inc. Chicago II, USA). Data were expressed as mean ± standard deviation (SD) or proportions (%). Association between categorical data was assessed using the chi-squared test while t-test was used for continuous data. The significance in the study was set at p<0.05.

Result

The mean age for total population was 20.5 ± 2.1 years. The baseline characteristics of the total population according to group, either urban or rural are depicted in **Table 1**. Rural youths were significantly more overweight and obese (49.4% vs 42.7%, $p < 0.044$) compared to urban youths. Those who reside in rural area were also shown to have significantly higher family history of hyperlipidaemia (16.3% vs 11.3%, $p < 0.036$).

Table 1 Baseline characteristics

Variables	Urban (n = 555)	Rural (n = 387)	Total (n = 942)	p value
Age in years ± (SD)	20.2 (2.2)	21.1 (1.7)	20.5 (2.1)	**< 0.001**
Male (n,%)	149 (26.8)	108 (27.9)	257 (27.3)	NS
Current smoker (n,%)	30 (5.4)	26 (6.7)	56 (5.9)	NS
Overweight and obese (n,%)	237 (42.7)	191 (49.4)	428 (45.4)	**< 0.044**
Central obesity (n,%)	150 (27)	96 (24.8)	246 (26.1)	NS
Diabetes mellitus (n,%)	1 (0.2)	1 (0.8)	2 (0.2)	NS
Hypertension (n,%)	3 (0.5)	2 (0.5)	5 (0.5)	NS
Family history hypercholesterolaemia (n,%)	64 (11.5)	63 (16.3)	127 (13.5)	**< 0.036**
Family history PCAD (n,%)	45 (8.1)	45 (11.6)	90 (9.6)	NS
NS – not significant				

Low-density lipoprotein (2.8 vs 2.7 mmol/L) and total cholesterol (TC) (4.7 vs 4.5 mmol/L) were significantly higher in urban compared to rural youths ($p < 0.019$ and $p < 0.012$ respectively) (**Table 2**). However, there were no differences or association between urban and rural youths in relation to HDL, TG, diabetes mellitus, smoking, hypertension, central obesity and family history of CAD.

Table 2 Biochemical analysis

Variables	Urban (n = 555)	Rural (n = 387)	Mean diff (95% CI)	t-statistics (df)	P value
LDL (mmol/L)	2.8 ± 0.8	2.7 ± 0.8	0.126 (0.021–0.230)	2.351	**< 0.019**
TC (mmol/L)	4.7 ± 0.9	4.5 ± 1.0	0.160 (0.035–0.285)	2.507	**< 0.012**
TG (mmol/L)*	1.1 ± 0.5	1.1 ± 0.5	0	0	NS
HDL (mmol/L)	1.4 ± 0.3	1.4 ± 0.3	0.033 (-0.009–0.075)	1.532	NS
Glucose (mmol/L)	5.0 ± 1.1	5.1 ± 1.5	-0.129 (-0.298–0.040)	-1.496	NS
Result presentation for independent t-test, unless stated otherwise.					
* Mann-Whitney U test					
NS – not significant					

Urban and rural youths received almost equal opportunity of education, where the education levels were statistically not significant between each group (**Table 3**).

Table 3 Education levels among Malaysian urban and rural youths

Education level	Urban (N = 480) n(%)	Rural (N = 347) n(%)	Total (N = 827) n(%)	p value
Primary school or lower	3 (0.6)	2 (0.6)	5 (0.6)	0.929
Secondary school (PT3- SPM)	106 (22.1)	63 (18.2)	169 (20.4)	0.167
Diploma (STPM)	217 (45.2)	177 (51.0)	394 (47.6)	0.099
Bachelor Degree	152 (31.7)	99 (28.5)	251 (30.4)	0.333
Post-graduate	2 (0.4)	6 (1.7)	8 (1.0)	0.057
* Chi-squared analysis, significant association ($p < 0.05$) between urban and rural youths				
^ Subjects without data of education level were excluded				

Overall, more youth in this study has CRF rather than not (Has CRF = 67.0% vs No CRF = 33.0%). Significantly more rural youths have at least one CRF compared to urban youths (rural = 71.6% vs urban = 63.8%, p = 0.012) (**Table 4**). Generally, rural youth individuals tend to have more CRF compared to urban youth, where the maximum number of CRF in rural youths (n = 2) was six, compared 5 CRF in an urban youth.

Table 4 The number of CRF

Number of Coronary risk factors (CRF)	**Urban (N = 555) n (%)**	**Rural (N = 387) n (%)**	**Chi-squared**	**p value**	**Odds ratio (95% CI)**
0	201 (36.2%)	110 (28.4%)	χ^2 (1) = 6.261	**0.012***	0.699 (0.528–0.926)
1 or more	354 (63.8%)	277 (71.6%)	χ^2 (1) = 6.261	**0.012***	1.430 (1.080–1.893)
1	143 (25.8%)	117 (30.2%)	χ^2 (1) = 2.277	0.131	1.248 (0.936–1.666)
2	114 (20.5%)	86 (22.2%)	χ^2 (1) = 0.386	0.535	1.105 (0.806–1.516)
3	82 (14.8%)	50 (12.9%)	χ^2 (1) = 0.651	0.420	0.856 (0.586–1.249)
4	14 (2.5%)	21 (5.4%)	χ^2 (1) = 5.374	**0.020***	2.217 (1.113–4.417)
5	1 (0.2%)	1 (0.3%)	χ^2 (1) = 0.066	0.797	1.435 (0.089–23.016)
6	0 (0.0%)	2 (0.5%)	χ^2 (1) = 2.874	0.090	NA
* Chi-squared analysis, significant association (p < 0.05) between urban and rural youths					
NA – not applicable					

Discussion

Our current study evaluated the CRF in Malaysian youths and compared them between the urban and rural youths in our country. To the best of our knowledge, the data that reported on this group of young adults is very scarce especially when comparing between the area of residence. Our study showed that CRF were significantly more prevalent among rural compared to urban youths, and the outcomes concurred with the Malaysian previous general population study[14, 15]. They reported that smoking, obesity, hypertension, diabetes and depression were identified as more prevalent among rural residents compared to urban[14]. Increasing urbanization and modernization may be one of the major causes to influence the more prevalent CRF in rural. The lifestyles changes in this population may have contributed to the current trend in our country and some other countries.

Prevalence of CRF between urban and rural populations are largely conflicting worldwide, and many factors may contribute to this for instance the countries' Gross Domestic Product (GDP). Smoking, obesity, hypertension, diabetes and hyperlipidaemia, were more rampant in rural population of certain countries like Sweden and India[16, 17], but reported to be on the contrary in other countries like China, Ghana and Peru[18–20]. Ezzati et al reported that CRF are expected to shift to low-income and middle-income countries and, with the persistent heavy burden of infectious diseases in these countries will further increase the global health inequalities[21]. Similarly, Rabin et al stated that GDP and obesity have a negative association in high-income European countries[22]. However, another study did not find any relationship between CRF (obesity, insufficient activity, systolic blood pressure, and fasting plasma glucose) with GDP. Comparably, Danaei et al indicated that a country's GDP level does not indicate that there must be health behavior change and health improvement endeavors and suggested that the countries' income has a rather indirect relationship with health behavior or health improvement endeavors[23]. However, majority of the aforementioned studies were conducted among general population without age grouping. The differences in socioeconomic, lifestyle and stress exposure across different age groups, the prevalence of CRF between general population and youths may be different.

Our study showed that rural group was significantly more overweight and obese, and has higher prevalence of family history with hypercholesterolaemia. This trend is interesting and also alarming at the same time showing that obesity is not entirely associated with the place of residence and urbanization or modernization may play an important role. In one study among 16 to 35 years old participants in a district in Malaysia, Pell et al reported that the prevalence was high with prevalence of overweight was 12.8% at ages 16–20 and 28.4% at ages 31–35 while obesity was 7.9% and 20.9% at the same age group respectively[24]. However, since it was only from one district, a comparison between rural and urban was not performed. They also highlighted that the pattern among this age group suggests that this is a significant period for change in health-related behaviours[24]. Other Malaysian studies looking at younger age group among the children and adolescents reported that the rural group had higher odds of overweight and obesity suggesting that rural environment may be more "obesogenic" in ways that a person-level analysis is unable to distinguish[25]. On contrary to another recent publication which reported that there was no significant difference in BMI status between rural and urban as well as between genders[26]. Interestingly, our neighboring country Indonesia reported that the prevalence of obesity was higher in urban children and adolescents compared to urban[27]. However, direct comparison is difficult due to the difference in the study group.

Despite the majority of CRF were more prevalent in rural youths in our study, urban youths had significantly higher LDL-c and TC compared to rural youths. Worse lipid profile is probably associated with high-fat diet or fast food which are more widely available in the city. Contrary to our findings, Nuotion et al reported that people living in urban areas had a more favourable CRF compared to rural residents. They reported that the general urban population had LDL-c, MS and Hba1c[28], albeit without restricting the age of the subjects. These contradicting findings leave us the question of what is the factor that dictate the CRF among youths, if the location of residency is not the determining factor. A study in Indian young adult population (age 26–32 years) had attempted to associate Household Possession Score, individual education and paternal education status with CRF. The study consistently found that subjects with higher score of these socioeconomic status indicators were associated with more CRF[29], regardless whether they are rural or urban residents, hypothesising that CRF is related to greater accessibility to food and less physically-straining job among higher socioeconomic status people.

If the main contributor of CRF among youths is socioeconomic status, the future preventive measure in preventing premature CVD death should focus in spreading awareness of healthy lifestyle among these high socioeconomic status youths, regardless if they are urban or rural residents. Higher education level can be an indicator of higher socioeconomic status, but since education coverage of Malaysian youths are quite uniform, additional information, such as household income, are required to deduce the cause of CRF among this group. However, some other studies in the Malaysian general population showed that better education is associated with less CRF for example obesity[30]. Our study found that other coronary risk factors like HDL, TG, diabetes mellitus, smoking, hypertension, central obesity and family history of CAD are not significantly different between urban and rural youths.

A significant strength of our study is the recruitment of a large number of participants from youth population. They were still not fully exposed to unhealthy lifestyle or therapeutic intervention, ie drug naïve, where they were not on anti-diabetic, anti-hypertensive, lipid-lowering agents and/or long-term antioxidant or anti-inflammatory therapy which may act as confounders. However, a perceived limitation is that the study is cross-sectional and hence is only able to demonstrate association rather than causal effect. The socioeconomic status of the subjects was also not being fully factored into the association with CRF in this study. Future longitudinal studies concentrating on this group of youths are vital to better understand the nature of the coronary risk profiles and aid in reducing the prevalence of CAD in later life.

Conclusion

In conclusion, rural youths are significantly heavier with higher family history of hyperlipidaemia compared to urban youths, while urban youths have higher LDL-c and TC levels. Other coronary risk factors are not significantly different between urban and rural youths. Generally, rural youths have more CRF than urban youths, but the cause of CRF in this youth group is still unclear. Healthy lifestyle awareness and intervention programmes are pivotal in these targeted groups of youths to reduce the CHD risk in later life.

Abbreviations

Acute coronary syndrome (ACS)

Body mass index (BMI)

Blood pressure (BP)

Cardiovascular disease (CVS)

Coronary artery disease (CAD)

Coronary risk factor (CRF)

Low-density lipoprotein cholesterol (LDL-c)

Total cholesterol (TC)

Declarations

Ethics approval and consent to participate

This research attained the approval and consent from the Universiti Teknologi MARA (UiTM) Ethics Committee Board. The study was carried out in accordance with the tenets of the Declaration of Helsinki. Participants and parents provided written informed consent prior to the participation in the research.

Consent to publish

Written informed consents were obtained from the parents and participants for the publication of this study.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

All authors drafted the article, critically revised the manuscript and approved the final manuscript.

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Figures

Figure 1

Map showing the screening sites and the number of participants included in this study Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.