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Hypertension in Young Adults – An Under-Estimated Problem

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ABSTRACT

Aim: To study the prevalence of hypertension and "white coat hypertension" in young adult Asian males, and identify the associated risk factors.

Methods: Population-based descriptive analysis of 3,352 Singapore military conscripts presenting consecutively for medical screening, followed by case-control study of subjects with elevated blood pressure. A standard protocol for assessing elevated blood pressure, 24-hour ambulatory monitoring and detailed interviews were performed. Main study outcomes are prevalence rate of hypertension and "white coat hypertension", mean blood pressure readings, and adjusted odds ratios for associated variables.

Results: Prevalence of hypertension and "white coat hypertension" was 1.6% (95% CI 1.2, 2.0) and 2.0% (95% CI 1.5, 2.5) respectively. Twenty-four-hour ambulatory monitoring was required to differentiate the two conditions, with a fall of 22.5mmHg (95% CI 19.7, 25.3) observed between first visit and day-time ambulatory mean systolic blood pressures. There was strong association between hypertension and obesity (adjusted odds ratio using Body Mass Index: 1.19, p<0.001). Other important variables included parental history of hypertension, Malay ethnicity and low socio-economic status, although there was no significant correlation in our regression model.

Conclusion: This study provides population-based data on hypertension in young Asian adults. While the prevalence of hypertension is low compared to older age groups, it remains important to detect cases early, as appropriate treatment may mitigate long-term cardiovascular risks and reduce target organ damage. There is a clear role for ambulatory blood pressure monitoring for differentiating true hypertension from "white coat hypertension". There may be a role for targeted screening of high-risk groups, particularly the obese.

Keywords: hypertension, white coat hypertension, screening, blood pressure, ambulatory monitoring

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INTRODUCTION

Hypertension is a growing health problem in Asia[1]. While most studies describe hypertension in older adults and the elderly[2,3] there is a paucity of data on hypertension in teenagers and young adults, as they are deemed to be at lower risk of developing the disease. With a growing problem of hypertension worldwide, there is a concern that hypertension in young adults may also be on the rise and that cases are not detected because of inadequate screening at this age group.

At the same time, the diagnosis of hypertension is known to be a problem in the young as a result of white coat hypertension, where systolic and diastolic blood pressures may be elevated at the time of measurement[4]. Repeat testing, home blood pressure measurement and ambulatory monitoring are sometimes required to distinguish this group from the true hypertensives[5].

This is the first population-based study to describe the epidemiology of hypertension and white coat hypertension in young adults in Singapore, involving a population of male military conscripts. Risk factors associated with hypertension in this age group are also studied. These findings provide insight into the magnitude of the hypertension problem in young adults, and are important in determining the need for early blood pressure monitoring, particularly for high-risk groups.

METHOD

Study Population

All male Singapore citizens are conscripted to undergo two to 2.5 years of national service, when they are between 17 and 23 years of age. Prior to their enlistment, they are required to undergo mandatory medical screening at the Medical Classification Centre, Ministry of Defence, Singapore. The population of males presenting at the Medical Classification Centre, is therefore, representative of the entire cohort of young males in Singapore, with the exception of individuals with significant mental or physical impairment who are exempt from medical examination. A total of 3,352 conscripts presenting

consecutively for medical screening at the Medical Classification Center over a nine-week period in 2001, were screened for hypertension using a standard protocol. All 118 subjects with elevated blood pressure were enlisted into the study. In addition, 105 normotensive controls were enlisted using randomly generated numbers over the same period.

Questionnaire

A force-choice questionnaire was administered by interview in English or in the subject's native language, by the same medical technician. Data were obtained on the subject's ethnicity, education status, and socio-economic status (based on total family income). Risk factors studied include parental history of hypertension, alcohol consumption, smoking history, caffeine intake and sleep pattern.

"Education level" is defined as the highest level of education pursued or currently pursuing, and is categorised according to the framework of the Singapore education system: Primary (grades 1-6), Secondary (grades 7-10), Vocational Training and Polytechnic, Pre-University (grades 11-12) and University. Alcohol consumption was quantified by the average number of units of alcohol consumed per week over the past one month (1 unit of alcohol = 1 mug of beer/1 glass of wine/1 shot of hard liquor), and categorised as: "No intake", "1 unit/week", "2-3 units/week", "4-5 units/week", or ">5 units/week". The average number of sticks of cigarettes smoked per day over the past one month was recorded; while caffeine intake was based on the daily consumption of coffee or tea and categorised as: "No intake", "1 cup/day", "2-3 cups/day", or ">3 cups/day". The average number of hours of sleep per night over the past one month was recorded, and categorised as "<5 hours", "5-7 hours" and ">7 hours".

Blood Pressure Measurement[6-8]

Blood pressure screening was performed for all subjects in a sitting position, using a TM-2654 (A&D Com Ltd - 3-23-14 Higashi-Ikebukuro, Toshima-ku, Tokyo 170 Japan) digital blood pressure monitor at heart level. Individuals with systolic pressure >140 mmHg, and/or diastolic pressure >90 mmHg, had repeat measurements by the same medical technician using a mercury sphygmanometer, after a 5-minute rest and after excluding smoking and caffeine ingestion within the preceding 30 minutes. A cuff bladder encircling at least 80% of the arm circumference was applied to the non-dominant arm, and disappearance of phase V Korotkoff sounds taken as the diastolic reading. The mean of two readings, recorded two minutes apart, was taken. If these readings differed by more than 5 mmHg, a further three readings were recorded at 2-minute intervals, and the mean of all five readings taken. The radial pulse rate was manually recorded over a 30-second period.

Any subject found to have mean systolic blood pressure >140 mmHg, and/or mean diastolic blood pressure >90 mmHg, was given an appointment within two weeks, for repeat blood pressure measurement using a similar protocol. If the pressure remained elevated at the second visit, 24-hour ambulatory blood pressure was measured using a Schiller BR-102 monitor (Schiller - Altgasse 686,340 Baar, Switzerland) applied to the non-dominant arm. The patient was instructed to perform normal passive activities and to rest the arm at heart level during measurements. Recordings were taken at half-hour intervals during the day and hourly at night (between 10 pm to 6 am). Tests with less than 14 valid readings during the day or less than seven valid readings at night were repeated. Subjects performing night-shift work, or who had performed night-shift work within the previous four weeks, were rescheduled for testing.

Case Definition

Based on the TASK II Consensus[9], subjects with ABPM readings of (mean 24-hour reading >135/85 mmHg, and/or diurnal >140/90 mmHg, and/or nocturnal >125/75 mmHg) were classified as "Hypertensives". Subjects with elevated sphygmanometer readings, but normal ambulatory blood pressure readings, were classified as "White Coat Hypertensives".

Subjects with hypertension previously diagnosed using ambulatory blood pressure monitoring, or who have been on regular medical treatment for hypertension for at least two years, were included in the study as "Hypertensives", but did not require ambulatory testing. For poorly documented cases and newly diagnosed hypertension without previous ambulatory testing, blood pressures measurements were performed only two weeks after stopping anti-hypertensive medications.

Clinical Examination

The Body Mass Index and body fat percentage were obtained using a Tanita TBF-215 (Tanita Corporation - 14-2,1-chrome, Maeno-cho, Itabashi-ku Tokyo, Japan) Body Composition Analyser. Subjects were made to void their bladders and remove all footwear prior to impedance measurements. Clinical and biochemical testing was performed for all cases of hypertension to exclude secondary hypertension, using a standard protocol.

Table I. Prevalence of hypertension and white coat hypertension in young adult males in Singapore by ethnicity.

	Total number	Hypertension		White Coat Hypertension	
		Number	Prevalence (%)	Number	Prevalence (%)
Chinese	2,615	35	1.3 (0.9, 1.8)	44	1.6 (1.2, 2.3)
Malay	536	14	2.6 (1.4, 4.3)	16	2.9 (1.7, 4.8)
Indian and Others	201	3	1.5 (0.3, 4.2)	6	2.9 (1.1, 6.4)
Total	3,352	52	1.6 (1.2, 2.0)	66	2.0 (1.5, 2.5)

Parentheses indicate 95% confidence intervals for prevalence rates

Statistical Analysis

Prevalence and mean data were presented to the 95% confidence interval (95% CI). Comparison of means was performed using the unpaired t-test; comparison of proportions using Fisher's Exact Test; and multiple logistic regression analysis of factors associated with hypertension was performed, using Intercooled Stata version 6.0 (Stata Corporation, College Station, Tex).

RESULTS

Of 3,352 males aged between 17 and 23 years old, 78% were Chinese, 16% Malay, and 6% Indian and of other ethnic descent, which were representative of the national ethnic composition. One hundred and eighteen (3.5%) had elevated blood pressure on initial testing, of which seven had well documented essential hypertension, and six had secondary hypertension from renal or systemic disease. One hundred and five subjects underwent ambulatory blood pressure monitoring, with 39 diagnosed to have hypertension, and 66 to have white coat hypertension. Overall prevalence of hypertension in this population of young adult males was 1.6% (95% CI 1.2, 2.0) (see Table I), of which 46.2% were not previously detected to have elevated blood pressure. 27.3% of cases of white coat hypertension had been previously diagnosed as hypertension by their doctors or from previous screening programmes in schools.

Mean blood pressures in our study population are summarised in Table II. There was a slight drop in mean systolic and diastolic blood pressure, as well as mean pulse rate, between the first and second visits. However, this was significant only in subjects with white coat hypertension, where a drop in mean systolic blood pressure (4.8 mmHg, p=0.002) and pulse rate (5.2 per minute, p=0.03) were observed. Mean pulse rate was higher for subjects with both hypertension and white coat hypertension, when compared to controls (p=0.002). In white coat hypertension, a fall in mean systolic blood pressure of 22.5mmHg (95% CI 19.7, 25.3, p<0.001) was noted between the first visit and the mean daytime ambulatory reading, while only a small drop in diastolic blood pressure was noted.

Prevalence of hypertension was 2.0 times (p=0.03) higher in Malays than the majority Chinese race, while prevalence of white coat hypertension was 1.6 times (p=0.05) higher (Table II). A high proportion of hypertensives (69.2%, 95% CI 54.9, 81.3) had a history of hypertension in one or both parents, as compared with white coat hypertensives (57.6%, 95% CI 44.8, 69.7) and normotensive controls (31.4%, 95% CI 22.7, 41.2). 40.9% (95% CI 20.7, 63.6) of subjects in the low total family income group (<S$1,000/month) had hypertension, compared with 21.6% (95% CI 15.9, 28.3) in the middle-income (S$1,000-5,000) and 17.6% (95% CI 3.8, 43.4) in the high-income (>S$5,000) groups.

Obesity was strongly associated with both hypertension and white coat hypertension. The mean Body Mass Index in subjects with hypertension was 31.6 (95% CI 29.7, 33.5), compared with 27.7 (95% CI 26.1, 29.2) in white coat hypertension; and 21.7 (95% CI 21.0, 22.4) in controls. Body fat percentage was 36.6% (95% CI 33.3, 39.9) in subjects with hypertension, compared with 29.5% (95% CI 27.3, 31.7) in white coat hypertension; and 20.8% (95% CI 19.6, 22.0) in controls.

In our population of young adults, no significant association was found between hypertension and education status, smoking history, alcohol and caffeine consumption, and the average number of hours slept per night.

The results of multiple logistic regression analysis are shown in Table III. A strong positive correlation was found between hypertension and Body Mass Index. After accounting for the other variables, regression analysis modelling showed no significant correlation between hypertension and ethnic group, parental history of hypertension and total family income.

DISCUSSION

The prevalence of hypertension in our study population of young adult males was 1.6% (95% CI 1.2, 2.0), which is low compared to the national crude

Table II. Mean blood pressure readings in young adult males in Singapore.

	Hypertension (n=52)			White Coat Hypertension (n=66)			Control (n=105)		
	SBP (mmHg)	DBP (mmHg)	PR (rate/min)	SBP (mmHg)	DBP (mmHg)	PR (rate/min)	SBP (mmHg)	DBP (mmHg)	PR (rate/min)
First visit	155.2 (151.1, 159.4)	86.4 (82.4, 90.3)	93.2 (88.2, 98.3)	148.9 (146.7, 151.1)	81.7 (79.1, 84.4)	94.0 (89.4, 98.7)	121.7 (120.0, 123.5)	71.7 (70.1, 73.3)	79.0 (76.1, 81.8)
Second visit	151.2 (147.3, 155.0)	82.6 (78.5, 86.7)	89.5 (85.2, 93.8)	144.2 (141.5, 146.9)	79.2 (76.5, 81.9)	88.9 (84.5, 93.3)	–	–	–
ABP (day mean)	141.6 (138.9, 144.4)	91.2 (87.6, 94.9)	85.5 (81.6, 89.4)	126.4 (124.5, 128.4)	80.1 (78.4, 81,9)	82.1 (79.2, 85.0)	–	–	–
ABP (night mean)	133.0 (128.6, 137.5)	84.8 (79.8, 88.6)	72.4 (68.4, 76.4)	116.8 (114.5, 119.2)	72.6 (70.5, 74.6)	67.5 (64.5, 70.5)	–	–	–
ABP (24-hour mean)	139.5 (136.9, 142.2)	89.2 (85.9, 92.5)	82.1 (85.9, 92.5)	124.0 (122.2, 125.9)	78.2 (76.6, 79.9)	78.5 (75.9, 81.0)	–	–	–

Case definition of hypertension based on TASK II Criteria for mean ambulatory blood pressure readings: 24-hour >135/85 mmHg, day (6 am - 10 pm) >145/90 mmHg, or night (10 pm-6 am) >125/75 mmHg.

SBP: systolic blood pressure, DBP: diastolic blood pressure, PR: pulse rate, ABP: ambulatory blood pressure.

Parentheses indicate 95% confidence intervals for mean values.

prevalence of 30.5% in males between 30-69 years of age[10]. Cases of hypertension tended to be mild, with the majority having isolated systolic hypertension. The low prevalence is expected, as young adults are at lower risk of developing hypertension[3]. There could also be over-reporting in the national survey, as ambulatory blood pressure monitoring was not performed to differentiate white coat hypertension from true hypertension[2,4].

In our population, 55.9% (95% CI 46.5, 65.1) of elevated blood pressure at first visit was eventually attributed to white coat hypertension. This is exceptionally high compared to other studies which report white coat hypertension rates of between 20 to 30%[2,4], and may be due to environmental factors related to being drafted into national service. It is also possible that young adults may have a more active sympathetic autonomic response[11] as reflected in the high mean pulse rate observed. With a repeat visit, both mean systolic blood pressure and pulse rate were observed to fall slightly, but this fall was not adequate to differentiate individuals with white coat hypertension. In the latter group, systolic blood pressure readings fell to normal levels only under 24-hour ambulatory monitoring, pointing to the usefulness of this test in diagnosing hypertension in younger age groups[12]. As current reference values for ambulatory monitoring in children and adolescents are based on statistical parameters of blood pressure distribution, the functional rather than distribution-based definitions of ambulatory hypertension have yet to be developed[9]. The prospective study of our study population will therefore be useful in establishing reference values for blood pressure measurement and in developing functional definitions of hypertension in young adults

Table III. Multivariate logistic regression analysis of factors associated with hypertension in young adult males in SIngapore.

	Number	Adjusted Odds Ratio	95% CI	p-value
BMI	223	1.19	(1.11, 1.26)	<0.001
Ethnicity				
Chinese	172	1.43	(0.33, 6.04)	0.63
Malay	33	1.58	(0.31, 7.97)	0.58
Others	18	1.00	–	–
Parental History				
Nil	122	1.00	–	–
Single	84	1.38	(0.64, 2.98)	0.41
Both	17	1.14	(0.30, 4.35)	0.85
Total Family Income				
Low (<$1,000)	22	2.57	(0.87, 7.61)	0.09
Middle ($1,000-5,000)	183	1.00	–	–
High (>$5,000)	17	1.39	(0.30, 6.33)	0.67

Risk factors of hypertension are not well studied in young adults[13]. In our study, obesity (based on Body Mass Index and body fat percentage) was strongly associated with hypertension, which is consistent with other studies[13,14]. It was also interesting to note the strong association between obesity and white coat hypertension. There appeared to be a two-fold prevalence of hypertension in Malays compared to other ethnic groups, which is consistent with the higher age-standardised prevalence rates observed in Malays in a national health survey[10]. The proportion of hypertensives was higher in individuals with a parental history of hypertension[13] and in individuals

from families of low socio-economic status (as indicated by total family income). Other known risk factors including smoking, diabetes mellitus and high cholesterol levels, were not associated with hypertension in our study. This could be attributed to the small number of hypertensives in our study, a result of the low prevalence of the condition in young adults. Alternatively, the cumulative duration of exposure to these risk factors is relatively low in young adults and is thus not a significant causative factor of hypertension in this age group.

While the prevalence of hypertension is relatively low in young adults, it nevertheless constitutes an important problem, as target organ damage is correlated with duration of disease[15], and early detection and management of hypertension may confer reduction in long-term risks of cardiovascular disease[16,17]. The role for systematic screening for hypertension in younger age groups needs to be further evaluated[3], and may be indicated in individuals with associated risk factors like obesity, parental history and certain ethnic groups. It is important to note that white coat hypertension accounts for more than half of cases initially detected to have elevated blood pressure, pointing to a clear role for ambulatory blood pressure monitoring in the diagnosis of true hypertension in young adults[16,18,19].

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