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ORIGINAL ARTICLE

Metabolic syndrome among garage workers in the automobile industry in Kumasi, Ghana

N. Amidu[1], W.K.B.A. Owiredu[2], E.K. Mireku[2] and C. Agyemang[3]

[1]Department of Medical Laboratory Science, School of Medicine and Health Sciences, University for Development Studies, Tamale, Ghana; [2]Department of Molecular Medicine, School of Medical Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; [3]Department of Public Health, Academic Medical Centre, University of Amsterdam, The Netherlands

Metabolic syndrome (MetS) is associated with cardiovascular diseases and diabetes but little is known about its prevalence among the active healthy population whose occupational activity is mainly manual and energy based. The aim of this study therefore, was to determine the prevalence of MetS and its components among garage workers in the automobile industry using three existing definitions. Two hundred garage workers were recruited from Bantama (86) and Sofoline (114) in Kumasi, Ghana. Anthropometric measurements including body mass index (BMI), waist to hip ratio (WHR) and waist to height ratio (WHtR) were measured. Blood pressure of subjects was also taken. Laboratory analysis included fasting blood sugar (FBS), total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C). The prevalence of MetS among the studied population was 18%, 16% and 13% using NCEP ATP III, WHO and IDF criteria respectively. Reduced HDL-cholesterol was the most prevalent component for ATP III (38.5%); central obesity was the most prevalent component for WHO (53.0%) and raised FBS was the most prevalent component for the IDF definition (54.0%). MetS seems to be on the increase among the manually active population even in the absence of obesity. There is therefore, an urgent need for a health policy shift towards control and prevention of MetS in Ghanaians.

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INTRODUCTION

Metabolic syndrome (MetS) constitutes a cluster of synergistically interacting cardiovascular risk factors which is mainly characterized by insulin resistance measured by the homeostasis model assessment or fasting insulin, abnormal glucose tolerance (fasting blood glucose or 2-hour postprandial blood glucose), atherogenic dyslipidaemia (increased triglycerides, decreased high-density lipoprotein cholesterol), elevated blood pressure and obesity (generalised obesity or central obesity) (Maumus *et al.*, 2005; Owiredu *et al.*, 2008). Other associated pathophysiologic conditions are physical inactivity, aging and polycystic ovarian syndrome (Motala *et al.*, 2009).

There are different definitions of MetS, including the criteria of the World Health Organization (WHO), European Group for the Study of Insulin Resistance, American Association of Clinical Endocrinology, National Cholesterol Education Program Adult Treatment Panel III (ATP III) and the International Diabetes Federation (IDF). Available data suggest that the prevalence of MetS vary according to age, ethnicity, race and criteria used (Cornier *et al.*, 2008). Though different countries and regions are at different stages, sub-Saharan Africa as a whole is at the centre of the most rapid demographic and epidemiologic transitions in world history. The future impact of this on the prevalence of the MetS is unknown, but is a matter of concern.

Correspondence: *N. Amidu, Department of Medical Laboratory Science, School of Medicine and Health Sciences, University for Development Studies, Tamale, Ghana. E*-mail: nafamidu@yahoo.com

None of the sub-Sahara African countries is excluded from the problems of poverty, increasing urbanization and westernization of lifestyle (Kamadjeu *et al.*, 2006).

The fact that physical inactivity and poor nutrient intake associated with modern lifestyle are thought to make a major contribution to the development of the syndrome poses the challenge of the increasing prevalence of MetS among the inactive workforce such as sedentary workers. According to global estimation, an epidemic of chronic diseases of lifestyle will increase and the largest proportional and absolute increases would occur in developing regions of the world, including Africa of which Ghana is no exception (Diabetes Atlas, 2006). This expected increase would be due in part to the projected increase in the urban population and in the aging populations across the world. Recent estimates by IDF for Africa indicates that among adults between 20–79 years, the regional prevalence of diabetes would increase from 3.1% in 2007 to 3.5% in 2025, with a corresponding 80% increase in numbers, from 10.4 million to 18.7 million (Diabetes Atlas, 2006).

Data on MetS are scanty in many African countries. The limited data from sub-Saharan Africa are based on clinical studies in defined high-risk groups of patients, such as those with type 2 diabetes (Titty *et al.*, 2008), pregnancy-induced hypertension (Turpin *et al.*, 2008) and chronic kidney disease (Owiredu *et al.,* under review). CVD risks and related complications are also said to vary very importantly between countries in sub-Sahara Africa (Addo *et al.*, 2007; Mensah, 2008). Besides, most of these studies are limited by the variable criteria used for defining MetS. Although the prevalence of CVD risk factors and of some of the individual components of the MetS have been reported, e.g. type 2 diabetes, obesity, and hypertension (Owiredu *et al.*, 2008), there is little information about the prevalence of the MetS or its components in workers whose occupation exposed them to conditions that might influence the prevalence of MetS. This study therefore seeks to determine the prevalence of MetS using WHO, NCEP ATP III and IDF definitions and the risk factor profile of MetS among garage workers in the automobile industry in Kumasi, Ghana.

MATERIALS AND METHODS

Subjects

This study was conducted between January and March, 2009. The subjects of this study were recruited from an adult population in Kumasi, Ashanti Region, Ghana. Two hundred men who work in the automobile garage industry (sprayers, straightener, auto mechanics, auto electricians, and smelters) in Bantama (n=86) and Sofoline (n=114) were recruited for this study. The study participants were predominantly male because the workforce is mainly men. The participation of the subjects was voluntary and informed consent was obtained from each subject. Subjects who were on medications that are known to modify serum lipid, blood pressure (BP), or carbohydrate metabolism were excluded from the study. The study was approved by the Committee on Human Research Publication and Ethics, KATH/SMS-KNUST, Ghana.

Sample collection and preparation

Five ml of venous blood sample was collected from the antecubital vein between 7 to 9 am after an overnight fast (12-16h). Two ml of the blood was dispensed into fluoride oxalate tubes whilst the rest was dispensed into vacutainer plain tubes. The samples in the fluoride oxalate tube and vacutainer plain tubes were centrifuged at 500 *g* for 15 min within 30 minutes of sample collection and separated into plasma and serum respectively. The plasma was used for the estimation of [glucose] while the serum was used for the estimation of lipid profile. The parameters that were determined include: Fasting Blood Sugar (FBS), Total Cholesterol (TC), Triglycerides (TG), High Density Lipoproteins (HDL-C) and Low Density Lipoproteins (LDL-C) using BT 3000 automated Chemistry analyzer. The methods adopted for the automated instrument for the determination of the above parameters were according to the reagent manufacturer's instructions - JAS™ diagnostics Inc. (JAS Diagnostics, Inc. Miami Florida, USA).

Anthropometric variables

Anthropometric measurements included height to the nearest 0.5 cm without shoes and weight to nearest 0.1 kg in light clothing were measured. Subjects were weighed on a bathroom scale (Zhongshan Camry Electronic Co. Ltd, Guangdong, China) and their height measured with a wall-mounted ruler. Blood pressure was taken by qualified nurses using a mercury sphygmomanometer and stethoscope. Measurements were taken from the left upper arm after subjects had been sitting for more than five (5) minutes in accordance with the recommendation of the American Heart Association (Kirkendall *et al.*, 1967). Duplicate measurements were taken with a 5 minute rest interval between measurements and the mean value was recorded to the nearest 2.0 mmHg.

Metabolic Syndrome Definitions

National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III).

MetS was defined according to the criteria of the National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III) to include individuals with three or more of the following five components: (1) abdominal obesity (waist circumference > 102 cm for men, or > 88 cm for women); (2) high TG ≥ 1.7 mmol L^{-1} ; (3) low HDL-C : men < 0.9 mmol L^{-1} or women < 1.0 mmol L^{-1} ; and (4) High BP (systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg or treatment of hypertension); and (5) high fasting glucose ≥ 6.1 mmol L^{-1} (NCEP, 2001).

International Diabetes Federation (IDF)

According to the new definition by the International Diabetes Federation (IDF) (Alberti et al., 2006), MetS can be diagnosed if central obesity (waist measurement >90 cm for men or >80 cm for women) is accompanied by any 2 of the following 4 factors: (1) TG levels of 1.7 mmol L^{-1} or greater, (2) an HDL cholesterol lower than 1.03 mmol L^{-1} for men or lower than 1.29 mmol L^{-1} for women, (3) a blood pressure (BP) of 130/85 mm Hg or greater or treatment of previously diagnosed hypertension, and (4) a fasting blood glucose (FBG) of 5.6 mmol L^{-1} or greater or previously diagnosed type 2 diabetes.

World Health Organization (WHO)

WHO criteria (1999) (Alberti *et al.*, 2006) requires the presence of diabetes mellitus, impaired glucose tolerance or insulin resistance and any two of the following: (1) Body mass index (BMI) ≥30 kg m^{-2} and/or waist-to-hip ratio >0.90 (male), >0.85 (female), (2) blood pressure ≥140/≥90 mm Hg or on medication, (3) diabetes ≥6.1 mmol L^{-1} or on medication for diabetes, impaired glucose tolerance or insulin resistance, (4) triglyceride ≥1.7 mmol L^{-1} and/or HDL-C <0.91 mmol L^{-1} (male), <1.01 mmol L^{-1} (female).

Statistical Analysis

The results are expressed as Means ± SEM. Unpaired *t*-test was used to compare mean values of continuous variables and χ^2 was used to compare categorical variables. A level of $p<0.05$ was considered as statistically significant. GraphPad Prism version 5.00 for windows was used for statistical analysis (GraphPad software, San Diego California USA, www.graphpad.com).

RESULTS

The general characteristics of the study population are as shown in Table 1. The mean age of the studied population was 30.2 ± 7.8 years and the mean duration of work was 8.0 ± 6.1 years. Whereas the prevalence of obesity using BMI, WC and WHR were 2.0% 1.0% and 1.0% respectively, the prevalence of hypertension and diabetes were 12.0% and 6.0% respectively (Table 1). Using Pearson's correlation, age and duration of work correlated positively with blood pressure (i.e. SBP and DBP) (data not shown).

The prevalence of MetS among the studied population was 18%, 16% and 13% using NCEP ATP III, WHO and IDF criteria respectively (Table 2). Using NCEP ATP III criteria, the highest prevalence of components of MetS was reduced HDL-C (i.e. 38.5%), followed by raised FBS (34.0%), raised TG (31.5%), raised BP (20.0%) and central obesity

(1.0%). From the WHO criteria, the highest prevalence of components of MetS was central obesity (53.0%), followed by raised FBS and raised TG (i.e. 34.0%), reduced HDL-C (17.0%) and finally raised BP (12.0%). Raised FBS had the highest prevalence rate (54.0%), followed by reduced HDL-C (38.5%), raised TG (31.5%), raised BP (20.0%), and obesity (19.0%) using the IDF criteria (Table 2). Using the IDF criteria, almost half of the study population had a metabolic score of two, whereas about 30% of the study population had a metabolic score of two using the NCEP ATP III and WHO criteria (Table 2).

Table 1: General characteristic of the studied population

Variables	Total (n=200)
Age (yrs)	30.2 ± 7.8
Duration of work (yrs)	8.0 ± 6.1
WC (cm)	82.9 ± 10.6
SBP (mmHg)	122.3 ± 17.5
DBP (mmHg)	75.9 ± 11.6
BMI (kg m^{-2})	24.1 ± 3.1
WHR	0.9 ± 0.1
Hb (mg dl^{-1})	14.2 ± 1.2
FBS (mmol L^{-1})	5.6 ± 0.9
TG (mmol L^{-1})	1.5 ± 0.5
HDL-C (mmol L^{-1})	1.1 ± 0.3
TC (mmol L^{-1})	4.5 ± 1.0
LDL-C (mmol L^{-1})	2.7 ± 0.8
Alcoholics (%)	23.3
Smokers (%)	4.7
Obesity-BMI (%)	2.0
Obesity-WC (%)	1.0
Obesity-WHR (%)	1.0
Hypertension (%)	12.0
Diabetes (%)	6.0

Data are presented as mean ± SD and categorical data presented as percentages. BMI – body mass index; WC –waist circumference; WHR – waist-to-hip ratio; Obesity-BMI = BMI ≥ 30 kg m^{-2}, Hypertension = blood pressure ≥ 140/90 mmHg, Obesity-WC = WC > 102 cm, Obesity-WHR = WHR >1.0, Diabetes = fasting blood sugar greater or equal to 7.0 mmol L^{-1}

Using the NCEP ATP III and WHO criteria, the study participants with MetS were significantly older and had been on the job for a longer period compared to those without MetS. Interestingly, straighteners were more associated with Mets (22.2%) compared to those without MetS (6.1%) as shown in table 3.

DISCUSSION

This study provides data on the prevalence of MetS and its components among occupational group subjects. In an active workforce such as garage workers in the automobile industry, it is presumed that since the nature of their vocation offers them the opportunity to be physically active, one would have expected that the MetS and its components would have been drastically reduced or even absent. However, this study has established that MetS is a major health problem, even among the healthy active population who are physically active with minimal sedentary lifestyle. These findings, thus, call for sector-specific strategies for health promotion and prevention or treatment of MetS and its specific components.

This study shows that about 13% to 18% of garage workers in the automobile industry in Kumasi can be classified as having the MetS depending on the definitive criteria. The prevalence of MetS was 18% and 16% among the studied population using the NCEP ATP III and WHO definition respectively. In contrast, the prevalence of MetS by using IDF definitions was 13%. These MetS prevalence rates observed in this study are similar to the 15.1% rate observed among installation and machinery operators and machine assemblers (Sanchez-Chaparro *et al.*, 2008) and the 12% prevalence rate observed among manual workers in Spain (Alegria *et al.*, 2005).

The main reason why the IDF criteria presented the lowest prevalence rate is due to over reliance of the IDF criteria on central obesity whose prevalence was very low in this study. Thus, when the IDF criteria is used, persons without central obesity who may have other characteristics of the MetS may not be diagnosed, whereas the use of the

Table 2: Prevalence of metabolic syndrome and its components among the studied population

Components of the MetS	NCEP-ATP III definition	WHO definition	IDF definition
Central obesity or obesity (%)	2(1.0)	106(53.0)	38(19.0)
Raised blood Pressure (%)	40(20.0)	24(12.0)	40(20.0)
Raised FBS (%)	68(34.0)	68(34.0)	108(54.0)
Raised TG (%)	64(31.5)	68(34.0)	64(31.5)
Reduced HDL-C (%)	77(38.5)	34(17.0)	77(38.5)
Prevalence of MetS (%)	36(18.0)	32(16.0)	26(13.0)
Metabolic score			
0	50(25.0)	40(20.0)	29(14.5)
1	87(43.5)	94(47.0)	65(32.5)
≥ 2	63(31.5)	66(33.0)	106(53.0)

Table 3: Prevalence of socio-demographic characteristic and work type among the studied population stratified by MetS

	NCEP ATP III		WHO		IDF	
Parameters	Present (n=36)	Absent (n=164)	Present (n=32)	Absent (n=168)	Present (n=26)	Absent (n=174)
Age (yrs)	33.8±10.0	29.4±7.1*	34.4±9.5	29.4±7.3*	30.5±6.9	30.1±8.0
Duration of work (yrs)	10.4±6.6	7.4±5.8*	10.0±6.4	7.6±6.0*	7.8±4.5	8.0±6.3
Alcoholics (%)	21.4	23.6	26.7	22.5	30	22.4
Smokers (%)	0.0	5.6	0.0	5.6	0.0	5.3
BMI ≥ 30 (kg m^{-2})	5.6	1.2	0.0	1.2	0.0	1.1
Work type (%):						
Welder	11.1	4.9	12.5	4.8	0.0	6.9
Vulganizer	0.0	4.9	0.0	4.8	0.0	4.6
Straiter	22.2	6.1*	12.5	8.3	7.7	9.2
Sprayer	5.6	6.1	12.5	4.8	0.0	6.9
Spare part	0.0	1.2	0.0	1.2	7.7	0.0
Scrap dealer	0.0	1.2	0.0	1.2	0.0	1.1
Mechanics	22.2	42.7	25.0	41.7	38.5	39.1
Liner	0.0	2.4	0.0	2.4	0.0	2.3
Automechanic	0.0	7.3	12.5	4.8	7.7	5.7
Autoelectrician	16.7	11.0	18.8	10.7	15.4	11.5

Data are presented as mean ± SD and categorical data presented as percentages, *p < 0.05 when those with metabolic syndrome were compared with those without metabolic syndrome using unpaired t-test or Fischer's exact test.

WHO definition may underestimate MetS in non-diabetic subjects because it is primarily based on the presence of diabetes or impaired glucose tolerance or insulin resistance. The NCEP ATP III definition however, seems to be more convenient because of its flexibility in terms of the criteria used to diagnose MetS.

Hypertension is a 'silent killer' in many countries including Ghana (Amoah, 2003a; Cappuccio *et al.*, 2004; Owiredu *et al.*, 2008) and an important component of the burden of cardiovascular disease in all medical care services (Lim *et al.*, 2000). The overall prevalence of hypertension in this study was 12.0% and remarkably this is close to about a third of the prevalence of 29.9% found among the general male population in Kumasi (Cappuccio *et al.*, 2004) and 28.3% reported in Accra (Amoah, 2003a). The 12.0% is also lower than the 19% to 48% reported by Bosu, (2010) in a systemic review of an epidemic of hypertension in Ghana. The nature of the work of these studied populations (more physically active) may be protective as demonstrated in the lower prevalence of both generalised and central obesity rates. Current knowledge also suggests the importance of increased body mass index especially visceral fat in the pathophysiology of hypertension (Fujita, 2007).

The 2.0% prevalence rate of obesity among the garage workers in the automobile industry who are physically active at work compares favourably with the national prevalence rate of 2.8% reported by Biritwum *et al.*, (2005). This indicates that lifestyle factors play an important role in the aetiology of obesity among the Ghanaian population. This prevalence rate is however, lower than the 4.2% found among the artistic professionals among Dutch workers (Proper *et al.*, 2010). Since this study focused on an active population whose occupational activity is mainly energy and manual based, it stands to reason that this could be a contributory factor to the low percentage levels of obesity compared to other published data (Amoah, 2003b; Amoah, 2003c; Owiredu *et al.*, 2008). Since the type of work is associated with the total daily physical activity (Proper *et al.*, 2006), it was assumed that those working in occupations that require a certain amount of physical activity, would have a low prevalence of obesity. Besides, there is increasing evidence for the association of sedentary behaviour and obesity (Brown *et al.*, 2005; Proper *et al.*, 2007).

Using the revised diagnostic criteria for diabetes by an Expert Committee of the American Diabetes Association (ADA, 1997) and World Health Organization (WHO) (Alberti *et al.*, 1998) (i.e. a threshold of fasting plasma glucose of 7.0 mmol L^{-1}), the prevalence of diabetes among this population was 6.0%, confirming that diabetes is on the ascendency among adult Ghanaians. The relatively high rate of diabetes among active artisan garage workers has important public health implications for health planners. There is an urgent need for a health policy shift towards control and prevention of diabetes in Ghanaians considering the expected rise in the rate of diabetes (King *et al.*, 1998) that is likely to accompany cultural modification and increasing urbanization. Though this study reports a lower prevalence of diabetes as compared to a previous study from Accra (7.7%) (Amoah *et al.*, 2002), it is higher than the 4.0% prevalence reported by Abubakari *et al.*, (2009) among urban adults in West Africa. Studies conducted in Cameroon, South Africa and Tanzania have also reported diabetes prevalence rates ranging from 0.7 to 10.6% (Levitt *et al.*, 2000).

CONCLUSION

The prevalence of metabolic syndrome among the studied population was 18%, 16% and 13% using NCEP ATP III, WHO and IDF criteria respectively. The main contributors to MetS in the study population are reduced HDL-cholesterol for ATP III; central obesity for WHO and raised FBS for the IDF definition which are all reported to be on the increase in prevalence in the general population of Ghana. There is therefore an urgent need for health policy makers to shift their attention towards control and prevention of MetS in Ghanaians considering the expected rise in the rate of MetS components that is likely to accompany cultural modification and increasing urbanization.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

Abubakari AR, Lauder W, Jones MC, Kirk A, Agyemang C, Bhopal RS (2009). Prevalence and time trends in diabetes and physical inactivity among adult West African populations: the epidemic has arrived. *Public Health* 123 (9): 602-614.

ADA (1997). Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care* 20(7): 1183-1197.

Addo J, Smeeth L, Leon DA (2007). Hypertension in sub-saharan Africa: a systematic review. *Hypertension* 50(6): 1012-1018.

Alberti KG, Zimmet P, Shaw J (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabet Med* 23(5): 469-480.

Alberti KG, Zimmet PZ (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med* 15(7): 539-553.

Alegria E, Cordero A, Laclaustra M, Grima A, Leon M, Casasnovas JA*, et al.* (2005). Prevalence of metabolic syndrome in the Spanish working population: MESYAS registry. *Rev Esp Cardiol* 58(7): 797-806.

Amoah AG (2003a). Hypertension in Ghana: a cross -sectional community prevalence study in greater Accra. *Ethn Dis* 13(3): 310-315.

Amoah AG (2003b). Obesity in adult residents of Accra, Ghana. *Ethn Dis* 13(2 Suppl 2): S97-101.

Amoah AG (2003c). Sociodemographic variations in obesity among Ghanaian adults. *Public Health Nutr* 6(8): 751-757.

Amoah AG, Owusu SK, Adjei S (2002). Diabetes in Ghana: a community based prevalence study in Greater Accra. *Diabetes Res Clin Pract* 56 (3): 197-205.

Biritwum R, Gyapong J, Mensah G (2005). The epidemiology of obesity in ghana. *Ghana Med J* 39(3): 82-85.

Bosu WK (2010). Epidemic of hypertension in Ghana: a systematic review. *BMC Public Health* 10: 418.

Brown WJ, Williams L, Ford JH, Ball K, Dobson AJ (2005). Identifying the energy gap: magnitude and determinants of 5-year weight gain in midage women. *Obes Res* 13(8): 1431 -1441.

Cappuccio FP, Micah FB, Emmett L, Kerry SM, Antwi S, Martin-Peprah R*, et al.* (2004). Prevalence, detection, management, and control of hypertension in Ashanti, West Africa. *Hypertension* 43(5): 1017-1022.

Cornier MA, Dabelea D, Hernandez TL, Lindstrom RC, Steig AJ, Stob NR*, et al.* (2008). The metabolic syndrome. *Endocr Rev* 29(7): 777-822.

Diabetes Atlas (2006). *International Diabetes Federation*. Brussels, Belgium: International Diabetes Federation

Fujita T (2007). Insulin resistance and salt-sensitive hypertension in metabolic syndrome. *Nephrol. Dial. Transplant.* 22(11): 3102-3107.

Kamadjeu RM, Edwards R, Atanga JS, Kiawi EC, Unwin N, Mbanya JC (2006). Anthropometry measures and prevalence of obesity in the urban adult population of Cameroon: an update from the Cameroon Burden of Diabetes Baseline Survey. *BMC Public Health* 6: 228.

King H, Aubert RE, Herman WH (1998). Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care* 21(9): 1414-1431.

Kirkendall WM, Burton AC, Epstein FH, Freis ED (1967). Recommendations for human blood pressure determination by sphygmomanometers. *Circulation* 36(6): 980-988.

Levitt NS, Unwin NC, Bradshaw D, Kitange HM, Mbanya JC, Mollentze WF*, et al.* (2000). Application of the new ADA criteria for the diagnosis of diabetes to population studies in sub-Saharan Africa. American

diabetes association. *Diabet Med* 17(5): 381-385.

Lim TO, Ding LM, Zaki M, Merican I, Kew ST, Maimunah AH*, et al.* (2000). Clustering of hypertension, abnormal glucose tolerance, hypercholesterolaemia and obesity in Malaysian adult population. *Med J Malaysia* 55(2): 196-208.

Maumus S, Marie B, Siest G, Visvikis-Siest S (2005). A prospective study on the prevalence of metabolic syndrome among healthy french families: two cardiovascular risk factors (HDL cholesterol and tumor necrosis factor -alpha) are revealed in the offspring of parents with metabolic syndrome. *Diabetes Care* 28(3): 675-682.

Mensah GA (2008). Epidemiology of stroke and high blood pressure in Africa. *Heart* 94(6): 697-705.

Motala AA, Mbanya JC, Ramaiya KL (2009). Metabolic syndrome in sub-Saharan Africa. *Ethn Dis* 19(2 Suppl 2): S2-8-10.

NCEP (2001). Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 285(19): 2486-2497.

Owiredu WKBA, Adamu MS, Amidu N, Woode E, Bam V, Plange-Rhule J*, et al.* (2008). Obesity and cardiovascular risk factors in a Pentecostal Population in Kumasi- Ghana. *J Med Sci* 8(1): 1-9.

Proper KI, Cerin E, Brown WJ, Owen N (2007). Sitting time and socio-economic differences in overweight and obesity. *Int J Obes (Lond)* 31(1): 169-176.

Proper KI, Hildebrandt VH (2010). Overweight and obesity among Dutch workers: differences between occupational groups and sectors. *Int Arch Occup Environ Health* 83(1): 61-68.

Proper KI, Hildebrandt VH (2006). Physical activity among Dutch workers--differences between occupations. *Prev Med* 43(1): 42-45.

Sanchez-Chaparro MA, Calvo-Bonacho E, Gonzalez-Quintela A, Fernandez-Labandera C, Cabrera M, Sainz JC*, et al.* (2008). Occupation-related differences in the prevalence of metabolic syndrome. *Diabetes Care* 31(9): 1884-1885.

Titty KF, Owiredu WKBA, Agyei-Frimpong MT (2008). Prevalence of metabolic syndrome and its individual components among diabetic patients in Ghana. *J Biol Sci* 8(6): 1057-1061.

Turpin CA, Ahenkorah L, Owiredu WKBA, Laing EF, Amidu N (2008). The Prevalence of the Metabolic Syndrome Among Ghanaian Pregnancy-Induced Hypertensive Patients Using the World Health Organisation and the National Cholesterol Education Program III Criteria. *J Med Sci* 8(5): 443-451.

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