# PREVENTING METABOLIC SYNDROME IN AFRICA: RISK IDENTIFICATION AND PHYSICAL ACTIVITY INTERVENTION

J. L. Ajiya

Correspondence: Jamilu Lawal Ajiya, Department of Physical and Health Education, +2347038858512, ajiya_mj@yahoo.co.uk

**Abstract**

*Metabolic syndrome (MetS) is becoming a major challenge to global public health. Contrary to earlier thoughts; metabolic syndrome is no longer rare in Africa. In Nigeria, using the World Health Organization criteria, full-blown metabolic syndrome was found in type 2 diabetic patients. This warrants effort to develop preventive and treatment strategies which are easier and natural. MetS prevention programmes comprise two integrated components: first, risk identification services and second, intensive life-style change programmes. This paper reviewed current literature on risk identification and physical activity intervention in people at high risk of developing MetS. The paper recommends moderate-intensity physical activity such as walking, jogging and cycling as safe and common to improve cardiometabolic health and decrease the risk of cardiovascular disease and diabetes.*

**Key words:** metabolic syndrome, risk assessment, physical activity intervention

**J. L. Ajiya,** Bsc, Msc, is a PhD student of Exercise and Sports Science in the Department of Physical and Health Education, Ahmadu Bello University Zaria.

## Introduction

The o n-going global rise in the prevalence of metabolic syndrome (MetS) among all age and ethnic groups is accompanied by a higher increase in serious health risks, such as type 2 diabetes mellitus (T2DM) and the development of cardiovascular diseases. MetS has been known as a cluster of risk factors for cardiovascular disease and type 2 diabetes mellitus (T2DM), which occurs together more often than by chance alone (Okafor, 2012; Mathew; Tamura and Chang, 2010). Research indicates a strong association between MetS and subsequent risks for diabetes and cardiovascular events. The metabolic syndrome is becoming a major challenge to global public health. For example, according to estimates from the American Heart Association, more than 95% of U.S children and adolescents, aged 12-19 years or nearly three million individuals have MetS. Thirty percent of obese Saudi children had three or more of the components of the MetS (Taha, Ahmed and Sadiq, 2009). The pathological processes and risk factors of MetS have been shown to begin during childhood. Researchers believe that the risk of developing the MetS is likely triggered or exacerbated by concurrent obesity, physical inactivity, poor eating habits, and hormonal changes, associated with puberty (Pettman, Misan, Owen, Warren, Coates, Buckley and Peter, 2008; WHO, 2002).

Contrary to earlier thoughts, MetS is no longer rare in Africa. In Nigeria, using the WHO criteria, full-blown MetS (presence of all major components) was found in 25.1% of T2DM subjects (Okafor, 2012). This warrants effort to develop preventive and treatment strategies which are easier and natural. Physical activity levels of Nigerian people, particularly youth, are moderate while sedentary behavious is high (Akinroye, Oyenyemi, Adukoya, Adeniyi, Adedoyin, Ojo, Alawode, Ozomata, and Awotidebe, 2014). As a response to the increased global sedentary and consequent risks of negative cardiometabolic outcomes, one response that has been adopted by many organizations concerned with health and environment is the promotion of “active life style”, which seeks to promote walking, jogging and cycling as safe and common to organized exercise training and sport.

MetS prevention programmes comprise two integrated components: first, risk identification services and second, intensive life-style change programmes. This paper reviewed current literature on risk identification and physical activity intervention to prevent the occurrence of metabolic syndrome.

**Diagnostic Criteria of Metabolic Syndrome**

Since the first descriptions of this clustering of metabolic risk factors, different organizations and researchers have proposed additional names and criteria to diagnose this condition. The World Health Organization suggested the first diagnostic definition of the metabolic syndrome as a clinical entity, using specific cut-off points for a set of physical and biochemical components. The European Group for Study of Insulin Resistance (EGIR), the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (EPDET-HBCA), National Cholesterol Education Programme (NCEP) and the American Association of Clinical Endocrinologists (AACE), have also proposed their own criteria for clinical diagnosis of metabolic syndrome (Alberti, Zimmet &Shaw, 2006; Balkau and Charles, 1999).

Most of the definitions require performing laborious and not well and widely standardized laboratory measures to demonstrate insulin resistance, or include less specific tests as glucose tolerance or microalbuminuria. In 2001, the Adult Treatment Panel [ATP III] of the US NCEP adopted the term 'metabolic syndrome' provided by previous definitions, and proposed the first that did not require complex laboratory tests (for example, insulin resistance measurements). Thus, metabolic syndrome can be diagnosed in an individual patient more easily by determining waist circumference and blood pressure and performing simple laboratory determinations, as blood glucose, triglyceride and HDL cholesterol levels.

The WHO clinical criteria for the metabolic syndrome states that in order to make a diagnosis of the CMS, a patient must be present with glucose intolerance, impaired glucose tolerance (IGT) or diabetes and/or insulin resistance, together with two or more of the following components:

1. Impaired glucose regulation or diabetes
2. Insulin resistance (under hyperinsulinaemic euglycaemic conditions, glucose uptake below lowest quartile for background population under investigation)
3. Raised arterial pressure ≥ 140/90 mm Hg
4. Raised plasma TG (≥ 1.7 mmol/L; 150 mg/dL) and/or low HDL-Chol (< 0.9 mmol/L, 35 mg/dL men; < 1.0 mmol/L, 39 mg/dL women)
5. Central obesity (males: waist-to-hip ratio > 0.90; females: waist-to-hip ratio > 0.85) and/or BMI > 30 kg/$m^2$

6. Microalbuminuria (urinary albumin excretion rate ≥ 20 g/dL or albumin: creatinine ratio ≥ 30 mg/g)

The IDF consensus group has in 2007 highlighted a number of other parameters (Table 1) that appear to be related to the MetS below which should be included in research studies to help determine the predictive power of the extra criteria for CVD and/or diabetes. The use of these additional factors in research may also allow further modification of the definition and the validation of the new clinical definition in different ethnic groups.

**Table 1: Extra Criteria for CVD/or Diabetes**

| Criteria | Variables |
|---|---|
| Abnormal body fat distribution | - General body fat distribution<br>- Central fat distribution<br>- Adipose tissue biomarkers: leptin, adiponectin<br>- Liver fat content |
| Atherogenic dyslipidaemia (beyond elevated triglyceride and low HDL) | - ApoB (or non-HDL-c)<br>- Small LDL particles |
| Dysglycaemia | - OGTT |
| Insulin resistance (other than elevated fasting glucose) | - Fasting insulin/pro-insulin levels<br>- HOMA-IR<br>- Insulin resistance by Bergman Minimal Model<br>- Elevated free fatty acids (fasting and during OGTT)<br>- M value from clamp |
| Vascular dysregulation (beyond elevated blood pressure) | - Measurement of endothelial dysfunction<br>- Microalbuminuria |
| Pro-inflammatory state | - Elevated high sensitivity C-reactive protein<br>- Elevated inflammatory cytokines (for example TNF-alpha, IL-6)<br>- Decrease in adiponectin plasma levels |
| Pro-thrombotic stat e | - Fibrinolytic factors (PAI-1 etc)<br>- Clotting factors (fibrinogen etc) |
| Hormonal factors | - Pituitary-adrenal axis |

Source: International Diabetes Federation 2007

## Risk Identification

The traditional methods of risk identification take into account classical risk factors such as age, sex, family history, blood pressure, smoking, cholesterol (both LDL and HDL), and diabetes. However, these risk assessment tools do not capture the risk of abdominal obesity and the related abnormalities of the metabolic syndrome. This is especially important with the recent sweeping epidemic of abdominal obesity, where many individuals are at increased risk of cardiovascular disease because of the presence of a constellation of metabolic abnormalities. Current definitions of the WHO and IDF comprises assessment of abdominal obesity.

Researchers have found that the risk of cardiovascular disease (CVD) becomes greater with increasing hyperglycemia and insulin resistance that occur in people long before the onset of clinical diabetes mellitus (Vasudevan and Ballantyne (2005; Okafor, 2012). Unfortunately, the current guidelines for risk assessment provided by medical societies and international organizations are numerous, confusing and inconsistent in their basic approach to identify specific risk factors for cardiovascular disease and diabetes mellitus in patients. According to Vasudevan and Ballantyne (2005) extending routine systematic assessment from cardiovascular risk factors to cardiometabolic risk- that is risk for developing CVD and DM- and increasing our understanding of the basic mechanisms that regulate energy balance and metabolic risk factors are needed to address this impending epidemic of metabolic syndrome. The term high, intermediate and low risks are used to refer to the results from a risk assessment tool. The terms used instead of specific numeral scores because the tools have different scoring systems. The term moderate risk' is used to denote a high risk assessment score where a (blood) test did not confirm that risk.

## Exercise Screening

Peoples considered to be at high risk for cardiovascular disease should undergo a thorough health screening and graded exercise test prior to beginning an exercise programme that includes moderate to vigorous intensity. The American College of Sports Medicine (ACSM) considers people with diabetes to be at high risk for cardiovascular disease and recommends this population to undergo a thorough health examination before participating in vigorous exercise programme (ACSM, 2010). The American Diabetic Association (ADA) recommends a graded

exercise test for individuals with diabetes aged over 35 years or those with type 2 diabetes for over 10 years and those with additional cardiovascular risk factors, Individuals with diabetes should be evaluated for diabetic complications that may contraindicate certain types or intensities of exercise (ADA, 2002). For instance, high-intensity aerobic exercise may be contraindicated for patients with proliferative retinopathy or uncontrolled hypertension (ADA, 2010). Henceforth, an individualized exercise regimen should be developed with respect to results from the health screening and evaluation, and the individual's age, physical activity level, and exercise goals and objectives. Other categories like the sedentary, who have not been exercising for a long time should also undergo health screening before participating in vigorous physical activity.

**Physical Activity Intervention**

Given that physical inactivity is a risk factor of diabetes, obesity, dyslipidaemia and hypertension, the prevalence of CMS was higher in subjects with poor physical activities (Bonora, *et al.*, 2005). IDF recommends that primary management for the metabolic syndrome is healthy lifestyle promotion. This includes moderate increase in physical activity. Sedentary behaviour is an important potential determinant of the metabolic syndrome. Several studies demonstrated that physical activity was inversely associated with the prevalence of metabolic syndrome (Brien and Katzmarzyk, 2006; Haram, et al., 2008; Farpour-Lambert, et al., 2009; Louise, *et al.*, 2016), notably among those who spent much time in sedentary activity as watching television or video or using computer (Ford et al., 2005). The adverse effect of excess television watching on obesity and other cardiovascular risk factors are thought to be attributed, in part, to decreased energy expenditure and, in other part, to increased energy intake. Therefore, understanding how sedentary behaviour relates to metabolic syndrome and the effectiveness of life-style intervention may provide new opportunities for clinical and public health approaches in its prevention and control (Matthew, et al., 2011; Unick, Beavers, *et al.*, 2013).

Various investigations and scientific reports have established the types and quantities of exercise to reduce the risk of CMS in adults (NCEP, 2001; Brage, *et al.*, 2011; Garber, 2011). Same is highly required for children. In the randomized study of Slentz (2004) there was a dose-response relationship between amount of exercise and amount of weight loss and fat mass. The high intensity exercise group lost significantly more body mass and fat mass than the

low/moderate intensity. Both aerobic continuous (Cambuli, *et al.*, 2008; Farpour-Lambert, *et al.*, 2009; Davis, *et al.*, 2012; Jago, et al., 2013) and interval training (Tjonna, 2008) in forms of walking/jogging and games indicate significance decreases in risk factors of CMS among adolescent group.

**Physical Activity Recommendation**

The Centre for Disease Control and Prevention (CDC, 2008) recommends 2 hours 30 minutes (150 minutes) every week of moderate or vigorous intensity exercise for adults. A recent study (Neto, Junior, Campos and Santos, 2014) on CMS risk score suggests that adolescents perform at least 88 minutes/day of moderate-to-vigorous physical activity (MVPA) to promote a healthy metabolic profile. The activities should include games, sports, recreation, planned exercise and transportation.

Similarly, international public health authorities, including WHO (WHO, 2010) recommends that children and adolescents should accumulate at least 60 minutes of MVPA daily to achieve higher results in CMS profile; While, the American Heart Association recommends of 30 minutes of moderate intensity (40-60% HR max) aerobic activity for a total of 150 minutes/week (AHA, 2009). Other studies in exercise science adopt a minimum of three days of varying exercise intensities to achieve meaningful results. Future research is required to establish meaningful benefits of low-to-moderate exercise intensities on CMS risk factors and biomarkers in adolescents.

**Monitoring Exercise Intensity**

Moderate-intensity physical activity requires an amount of effort and noticeably accelerates the heart rate. Examples include brisk walking, house work and domestic chores. On an absolute scale, moderate-intensity is defined as physical activity that is between 3 and 6 metabolic equivalents (METs).While, vigorous-intensity physical activity requires a large amount of effort, causes rapid breathing and a substantial increase in heart rate. Examples include running and climbing briskly up a hill. On an absolute scale, vigorous-physical activity is defined as physical activity that is above 6 METs.

From the fore-going discussion, moderate-intensity physical activity seems to be enough to improve cardiometabolic health and reduce risks. For non-professional individuals it may be

difficult to quantify the volume of workload and quantify the exercise to the recommended intensities using the absolute scales. However, there are simpler methods to determine exercise intensities. For example, Borg found that a high correlation exists between a person's perceived exertion rating times 10 and the actual heart rate (Borg, 1998, as in CDC, 2015). Moderate intensity translates (Table 2) to 12-13 points on the Borg's scale of perceived exertion. Multiplying this points by 10, that is: 12-13 (10) equals 120-130 beats per minute. Hence, a person who wants to exercise at moderate intensity supposes to exercise between 120-130 beats per minute. He can monitor the heart beat during exercise using heart rate monitor.

**Table 2: Classification of Intensity of Exercise**

| HRmax | $VO_2$ max or HRmax (beat/min) | RPE (20-Point scale) % | Intensity | Heart beat (beats/minutes) |
|---|---|---|---|---|
| 35 | 30 | 10 | very light | 100 |
| 35-59 | 30-49 | 10-11 | light | 100-110 |
| 60-79 | 50-74 | 12-13 | moderate | 120-130 |
| 80-89 | 75-84 | 14-16 | heavy | 140-160 |
| 90 | 85 | 16 | very heavy | 160 |

Source: Modified from Pollock and Wilmore, 1995.

**Conclusion and Recommendation**

As a response to the increased global sedentary and consequent risks of negative cardiometabolic outcomes, one response that has been adopted by many organizations concerned with health and environment is the promotion of "active life style". This paper reviewed literature on risk identification and intervention for people at high risk. The paper recommends moderate-intensity physical activity such as walking, jogging and cycling as safe and common to improve cardiometabolic health decrease the risk of cardiovascular disease and diabetes.

## Reference


Akinroye, K.K., Oyenyemi,A.L., Adukoya, O.O., Adeniyi, A.E., Adedoyin, R.A., Ojo, O.S., Alawode, D.A., Ozomata, E.A., and Awotidebe, T.O. (2014). Results from Nigeria's 2013 report card on physical activity for children and youth. *Journal of Physical Activity and Health, 1*, S88-92. Doi.10.1123/jpah.2014.0881.

Alberti KG, Zimmet P, Shaw J. (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabetes Medicine, 23* (5):469–80.

American College of Sprots Medicine (2010). ACSM's Guidelines for Exercise Testing and Prescription. 8th Edition. PA, USA: Wolters Kluwer Health/Lippincott Williams & Wilkins.

American Diabetes Association (2002) Diabetes mellitus and exercise. *Diabetes Care, 25*(1):S64–S68.

American Diabetes Association (2010). Standards of medical care in diabetes. *Diabetes Care, 33*(1):S11–S61.

American Heart Association, AHA (2009). Progress and challenges of cardiometabolic syndrome in children and adolescents. AHA Scientific Statement. *Circulation, 119*: 624-628.

Balkau, B. and Charles, M.A. (1999). Comment on the provisional report from the WHO consultation. *Diabetic Medicine, 16*: 442-443.

Brage, S., Wedderkopp, N. and Ekulund, U. (2004). Featuures of the metabolic syndrome are associated with objectively measured physical activity and fitness in Danish children (The Earopean Youth Heart Study). *Diabetes Care, 27* 9): 2141-2148.

Brien, S.E. and Katzmarzyk, P.T (2006). Physical activity and the metabolic syndrome in Canada. *Applied Physiology and Nutrition Metabolism, 31*:40-47.

Cambuli, V.M., Musiu, M.C., Incani, M., Paderi, M., Serpe, R., Maras, V. Cossu, E., Cavallo, M.G., Mariotti, S., Loche, S. and Baroni, M.G. (2008). Assessment of adiponectin and leptin as biomarkers of positive metabolic outcomes after lifestyle intervention in overweight and obese children. *The Journal of Clinical Endocrinology and Metabolism, 93* (8): 3051-3057. doi: 10.1210/jc.2008-0476.

Centres for Disease Control and Prevention- CDC (2008). How much physical activity do adults need. Centres for Disease Control and Prevention.

Centres for Disease Control and Prevention- CDC (2015). Perceived exertion (Borg rating of perceived exertion scale). Centres for Disease Control and Prevention.

Farpour-Lambert, N., Aggoun, Y. and Marchand, L.M. (2009). Structured physical activity reduces blood pressure and improves early markers of atherosclerosis in pre-pubertal obese children. *Journal of the American College of Cardiology,* 54 (25).

Ford, E.S., L.I, C., Zhao, G., Pearson, W. and Mokdad, A. (2007). Prevalence of the metabolic syndrome among U.S. adolescents using the definition from the International Diabetes Federation. *Diabetes, 31*(3): 587-589. doi: 10.2337/dc07-1030.

Garber, C.E. (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine & Science in Sports & Exercise, 43*(7): 1334–59.

Haram, P.M., Kemi, O.J., Lee, S.J., Bendheim, M.O., Al-Share, Q.Y., Waldum, H.L. Gilligan, L. J., Koch, L.G., Britton, S.L. Najjar, S.M. and Wisloff, U. (2008). Aerobic interval training vs. continuous moderate exercise in the metabolic syndrome of rats artificially selected for low aerobic capacity. *Cardiovascular Research, 81*: 723- 732. Doi: 1093/cvr332.

International Diabetes Federation – IDF (2007). The IDF worldwide definition of the metabolic syndrome. Part 1: Worldwide definition for use in clinical practice. Retrieved from: http//www.idf.org/webdata/docs/metabolic_syndrome_definition.

Jago, R., Drews, K.L, McMurray, R.G, Baranowski, T., Galassetti, P., Foster, G.D., Moe, E. and Buse, J.B. (2013). BMI change, fitness change and cardiometabolic risk factors among 8th grade youth. *Pediatric Exercise Science, 25* (1):52-68.

Louise, H.; Naylor, L.H.; Davis, E.A. and Green, D.J. (2016). *Physiological Reports, 4*(4), e12713. Doi.1014814/phy2-12713.

Matthew, N.G., Singh, S. and Arora, R. (2011). Cardio-metabolic syndrome: definition, management, and prognosis. *Journal of Clinical Metabolism & Diabetes, 2* (2), , 45- 53.

National Cholesterol Education Program (NCEP) (2001). Executive summary of the Third Report of The National Cholesterol Education Program Expert Panel on detection, evaluation, and treatment of high blood cholesterol In Adults (Adult Treatment Panel III). *Journal of the American Medical Association, 285:* 2486-2497.

Pettman, T.L., Misan, G.M., Owen, K., Warren, W., Coates, A.M., Buckley, J.D. & Peter, R.C. (2008). Howe self-management for obesity and cardio-metabolic fitness: Description and evaluation of the lifestyle modification program of a randomised controlled trial. *International Journal of Behavioural Nutrition and Physical Activity, 5*: 53 doi: 10.1186/1479-5868-5-53.

Okafor, C.I. (2012). The metabolic syndrome in Africa: Current trends. *Indian Journal of Endocrinology & Metabolism, 16* (1): 56-66. doi: 10.4103/2230-8210.91191.

Taha, D., Ahmed, O. & Sadiq, B. (2009).The prevalence of metabolic syndrome and cardiovascular risk factors in a group of obese Saudi children and adolescents: A hospital-based study. *Annals of Saudi Medicine, 29*(5): 357–360.doi: 10.4103/0256-4947.55164.

Tjønna, A.E., T. O. Stølen, A. and Bye (2008). Aerobic interval training reduces cardiovascular risk factors more than a multi-treatment approach in overweight adolescents. *Clinical Science, 116*(4): 317–326.

Unick, J.L., Beavers, D., Bond, D.S., Clark, J.M., Jakicic, J. M., Kitabochi, A. E., Knowler, W.C., Wadden, T.A., Wagenknecht, L.E. and Wing, R.R. (2013). The long-term effectiveness of a lifestyle intervention in severely obese individuals. *The American Journal of Medicine, 126*(3): 236-242.

Vasudevan and Ballantyne (2005). Cardiometabolic risk assessment: an approach to the prevention of cardiovascular disease and diabetes mellitus. *Clinical Cornerstone, 7* (2-3), 7-16.

World Health Organisation (2002). Reducing risks, promoting healthy life. WHO, Geneva, Swtizerland. Retrieved from:http//www.int/who/2002/en/who2_enpdf.