WAGING WAR ON THE DEADLY QUARTET AND ITS CO-MORBIDITIES: A Physical Activity Panacea

BAYERO UNIVERSITY KANO
PROFESSORIAL INAUGURAL LECTURE
NO. 39

Danladi Ibrahim Musa
NCE, B.Ed., M.Ed,(ABU); PhD (OAU); CWFellow
Professor of Exercise Physiology,,
Department of Physical and Health Education,
Bayero University, Kano..

BAYERO
UNIVERSITY PRESS

DATE:- 25TH APRIL 2019

Published 2019 by:
Bayero University Press,
Main Library Building,
Bayero University Kano,
New Site, Gwarzo Road,
P.M.B. 3011.
Kano.

Website: *www.buk.edu.ng*
E-mail: *info.bukpress@buk.edu.ng*
Tel:- 08060451857

ISBN 978 - 978 - 56916 - 8 - 9

PRINTED BY BAYERO UNIVERSITY PRESS KANO, NIGERIA

Danladi Ibrahim Musa

NCE, B.Ed., M.Ed,(ABU); PhD (OAU); CWFellow

Professor of Exercise Physiology,,

Department of Physical and Health Education,

Bayero University, Kano.

SUMMARY OF PRESENTER'S BIODATA

Danladi Ibrahim Musa hails from Abocho Ajonoja in Dekina Local Government Area of Kogi State, Nigeria. He earned his PhD from the prestigious Obafemi Awolowo University (OAU), Nigeria in 1998; M.Ed and B.Ed from Ahmadu Bello University (ABU), Nigeria in 1987 and 1982 respectively and the Nigeria Certificate in Education from Advanced Teachers' College, Ahmadu Bello University in 1977.

Professor Musa joined Bayero University from Advanced Teachers' College, Ahmadu Bello University, Kano in September, 1989. He was promoted to the position of Professor in October, 2002 having moved through the various levels of academic cadre of the University and has served in several capacities as member of many committees at the Departmental, Faculty and University levels. He was Head of Department of Physical and Health Education for six years. From Bayero University, he moved to Benue State University in October, 2005 where he served as a Professor and Coordinator of Human Performance Laboratory. He is currently a Professor in the Department of Human Kinetics and Health Education and Director of Research and Innovation at the Kogi State University. Before his current position, he served as Dean, Faculty of Education and Dean, School of Postgraduate Studies.

He was a recipient of the World Bank Junior Fellowship in 1994 to pursue his doctoral research at the Louisiana State University, USA. He was also a recipient of the prestigious Commonwealth Academic Staff Fellowship tenable at the University of Exeter, UK where he undertook a post-doctoral research in 2010/2011.

Professor Musa has taught for about 30 years including classes in exercise science, research methods, educational statistics and data processing and the general area of physical education. He has published over 60 scientific and research articles, ten co-authored books and sixteen book chapters and conference papers particularly on physical fitness and health promotion with emphasis on children and youth in many local and international journals.

He is a member of the Editorial Boards of JONAPHER: SD and JONASSM. He is the current Editor-in-Chief of the JONASSM.

Professor Musa is a member of many professional associations including National Strength and Conditioning Association (NSCA); American Association for Health, Physical Education, Recreation and Dance (AAHPERD); British Association of Sports and Exercise Science; International Society for the Advancement of Kinanthropometry (ISAK); Nigerian Association for Physical Health Education, Recreation, Sports and Dance (NAPHER.SD); Africa Association for Physical, Health Education, Recreation, Sports and Dance.

During his career, Professor Musa has supervised two PhD theses, more than 40 Master's dissertations and numerous Bachelor degree projects. He has examined ten PhD's and over 40 Master's candidates both within and outside the country. During his leisure time, he enjoys jogging, badminton and music. Professor Musa is happily married with children.

WAGING WAR ON THE DEADLY QUARTET AND ITS CO-MORBIDITIES: A Physical Activity Panacea

Preamble

I will start this lecture by giving thanks and praises to the Almighty, the Gracious and the Merciful for giving me the opportunity to communicate a bit of the knowledge He made possible for me to acquire during my adventure in the academics. I will particularly like to thank the Vice-Chancellor for his aggressive encouragements for this age-long tradition of inaugural lecture presentation series.

Sir, let me crave your indulgence to acknowledge my parents – late Mallam Ibrahim Etila Musa and late Amina Omeji Ibrahim for equipping me with sound moral, spiritual and Western education that formed the foundation for me to attain professorial status in this prestigious Nigerian University, Bayero University, Kano.

This lecture, titled: *Waging War on the Deadly Quartet and its Co-morbidities: A Physical Activity Panacea*, is a summary of my over 30 years of research and experience in the physical activity profession. Mine is the second inaugural lecture from the 30-year old Physical and Health Education programme of this University.

Definition of Terms

In order to have a better understanding of this discourse, there is need to define certain terms that will be frequently used in this presentation: these include; Physical Activity (PA), Physical Fitness (PF), Exercise, Health, and Insulin Resistance.

Physical Activity

Physical activity (PA) is often used interchangeably with 'physical fitness' and 'physical exercise', although each of them has specific meanings. Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell and Christenson, 1985). Many occupations involve a great deal of physical activity, for example, farming, blacksmithing, carpentry, bus conducting, lumberjack, just to mention a few. These are called occupational PA. When people engage in PA during their free times, this is referred to as leisure-time physical activity.

Physical Fitness

Nieman (2003) defines physical fitness as dynamic state of energy and vitality that enables one to carry out daily tasks, to engage in active leisure-time pursuits, and to

meet unforeseen emergencies without undue fatigue. In addition, physically fit individuals have a decreased risk of chronic disease and are more able to function at the peak of intellectual capacity. According to Robergs and Keteyian (2003), physical fitness is a state of bodily function that is characterised by the ability to tolerate exercise stress. On his own part, Clarke (1967) defines physical fitness as the ability to last, to bear up, to withstand stress, and to persevere under difficult circumstances, where an unfit person would give up. Howley and Franks define physical fitness as a set of attributes that people have or achieve relating to their ability to perform physical activity (Howley & Franks, 1997).

Exercise

Exercise has been defined as a sub-category of PA that is planned, structured, repetitive and purposeful, in the sense that improvement and maintenance of physical fitness is an objective (Caspersen, Powell and Christenson, 1985). According to Nieman (2003), exercise is physical exertion of sufficient intensity, duration, and frequency to achieve or maintain fitness or other health or athletic objectives. When an individual participates in PA for a particular purpose, for example, development of physical fitness or improvement in health conditions, this is called exercise. Exercise is prescribed according to a personal goal.

Health

The World Health Organisation (WHO) defines health as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Howley and Franks (1997) define health simply as "being alive with no major health problems. This is also called apparently healthy".

Insulin Resistance

This is a condition in which normal amounts of insulin secreted by the pancreas are inadequate to produce a normal insulin response in the muscle or liver. Consequently, the pancreas secretes additional insulin thereby elevating the insulin levels in the plasma. High levels of insulin in the plasma often lead to the development of Type 2 Diabetes or metabolic syndrome. Simply put, it is a deficient target cell response to insulin. The body cannot effectively use insulin in the muscle or liver even though sufficient insulin is produced (Donley, 2009).

It is a well-known fact that there has been great technological advancement since the time of the industrial revolution. Much of the work that used to be accomplished through physical labour is now done with automatic machines; elevators and escalators have replaced stairs in our modern buildings, air-planes and cars have

replaced walking as a mode of transportation, robots are fast taking over the role of humans at home and in workplace. These developments along cultural and modern lifestyles have greatly limited the physical exertion level of an average person, resulting in excessive energy conservation which the body ultimately converts to fat for storage. This scenario gives rise to degenerative diseases such as coronary heart disease, stroke, diabetes mellitus, and sudden death. These chronic diseases have been recognised to be mediated by clustering of both cardiovascular diseases (CVD) and metabolic risk factors referred to as metabolic syndrome (MS) (Beilby, 2004; Brambilla, Pozzobon & Pietrobelli, 2011; Kaur, 2014).

Mr. Vice-Chancellor Sir, in this lecture, I intend to share my research activities and experience in my area of research interest, that is, physical activity and health promotion. An attempt will be made to discuss metabolic syndrome (the deadly quartet) and the role physical activity plays in the early prevention of this disorder. The prevention of metabolic syndrome in youth is important as this guarantees better health prospects during adult life.

The Metabolic Syndrome (MS)

Metabolic syndrome is the constellation of adverse cardiovascular disease (CVD) and metabolic risk factors that include elevated abdominal obesity, high blood pressure, elevated triglycerides, elevated plasma glucose and diminished high-density lipoprotein cholesterol (HDL-C) (Beilby, 2004). The clustering of these risk factors has been shown in both adults (Whaley, Kamlpert, Kohl & Blair, 1999) and adolescents (Anderson, Wedderokopp, Hansen, Cooper & Froberg, 2003). Most individuals who develop CVD have multiple risk factors, and some of these risk factors commonly cluster together and termed MS. The MS otherwise known as the syndrome X was first described by Gerald M. Raevan in the 1980s. Since this time, numerous definitions and diagnostic criteria have been presented (Sarafidis & Nilsson, 2006). It is now recognised that insulin resistance, obesity, hypertriglyceridemia, and hypertension cluster in some person, leading to a markedly elevated risk of cardiovascular disease and Type 2 diabetes. This clustering has been termed the deadly quartet, Syndrome X and now, the MS (Brotman & Girod, 2002).

According to Brotman and Girod (2002), the metabolic syndrome can be thought of as a state of insulin counter-regulatory overdrive (Figure 1), in which insulin chronically duels with counter-regulatory hormones, such as glucorticoids, glucagon, and catecholamine, along with free fatty acids. In this biochemical tug-of-war, insulin is trying to store fuel, while counter-regulatory hormones and fatty acids are trying to prevent fuel storage. This on-going battle is perceived to cause the complex abnormalities of the MS.

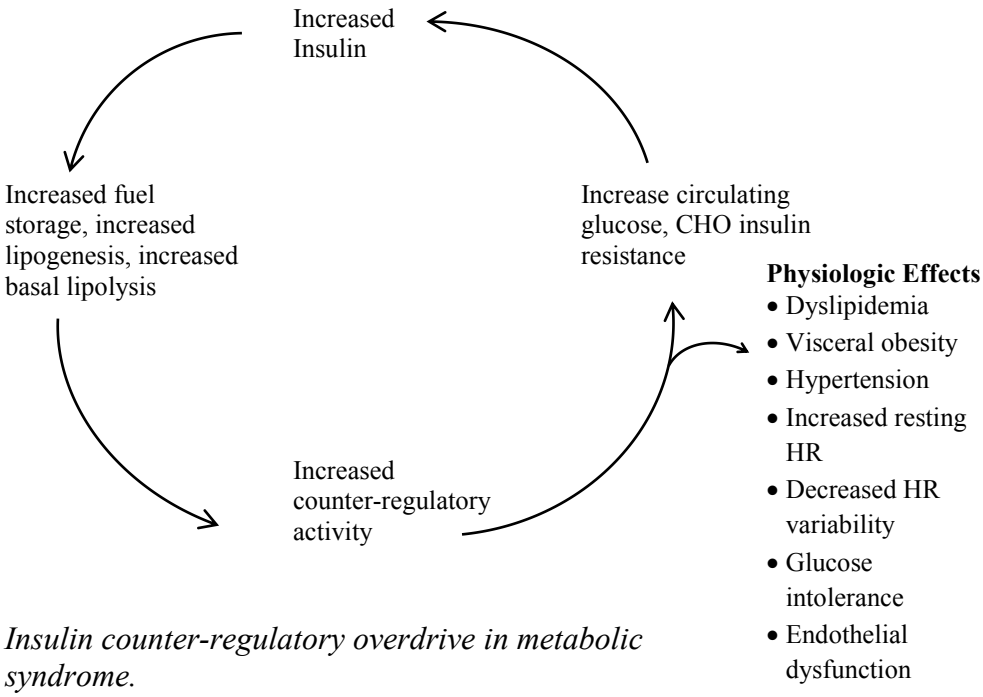


Fig. 1: *Insulin counter-regulatory overdrive in metabolic syndrome.*

The primary clinical outcome of MS is the CVD. However, most people with MS have insulin resistance, which confers an increased risk of type 2 diabetes or non-insulin dependent diabetes mellitus (NIDDM). When NIDDM becomes clinically apparent, CVD risk rises sharply.

In adults, the definition of MS varies in terms of diagnostic criteria and cut points used. The definition of WHO (Alberti and Zimmet, 1998) and the European Group for the Study of Insulin Resistance (EGIR) (Balkau and Charles, 1999) include measures of insulin resistance, but the definition used by the US National Cholesterol Education Programme (NCEP) (Cleeman, 2001) includes abnormalities in any three of the following risk factors: systolic BP, waist circumference, glucose level, triglyceride level and HDL-C level (insulin is not included). The definition used by the International Diabetes Federation (IDF) (2005) requires central obesity plus any two of the following risk factors: reduced HDL-C level, raised BP, elevated triglycerides level and elevated fasting plasma glucose level. There have been several definitions of MS but the most commonly used criteria for definition presently are from the WHO, EGR, NCEPIII, AACE and IDF. Metabolic syndrome in paediatric population includes the use of adult cut points or a single set of cut points for all ages of

childhood. But neither insulin concentration nor central obesity is included in the definition of MS for the paediatric age group (Kelishadi, 2007).

Table 1: *Diagnostic Criteria proposed for the Clinical Diagnosis of MS*

Clinical measures	**WHO (1998)**	**EGIR (1999)**	**ATP III (2001)**	**AACE (2003)**	**IDF (2005)**
Insulin resistance	IGT, IFC, NIDDM or lowered insulin sensitivity plus any 2 of the following	Plasma insulin > 75th perceutice plus any 2 of the following	None but any 3 of the following	IGT or IFC plus any of the following based on the clinical judgement	None
Body weight	Men: WHR>0.90. Women: WHR>0.85 BM1 > 30kg.M^2	WC ≥ 9cm in men or ≥80cm in women	WC ≥ 102cm in men or ≥ 88cm in women	BM1 ≥ 25KG.M^{-2}	Increased WC plus any 2 of the following
Lipids	TGs ≥ 150 mg/dL and or HDL-C < 35mgld in men or < 39mgldl in women	TGs ≥ 150mgld and or HDL-C <39mgldl in men or women	TGs ≥ 150mgld and HDL-C40mg/dl in men or <50mg/dl in women	Same as ATPIII	Same as ATPIII
BP	≥140/90mmHg	.≥140/90mmHg	≥130/85mmHg	Same as ATP III	Same as ATP III
Glucose	IGT, IFG or NDDM	IGT, IFG(but not diabetes)	>110mg/dl(includes diabetes)	IGT,IFG (but not diabetes)	≥100mgldl (includes diabetes)
Other	Creatine ratio of >30mglg or microlburninuria urinary excreaton rate of >20mglmin			Other features of insulin resistance	.

Source: *Kaur, J. (2014). Cardiology Research and Practice.*

NCEP ATP III: National Cholesterol Education Programme Adult Panel III
AACE: American Association of Clinical Endocrinologists
IGF: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance.

Prevalence of Metabolic Syndrome

The worldwide prevalence of MS in the adult population is estimated to be 20-25% (IDF, 2005), largely as a result of greater obesity and sedentary lifestyles. Studies assessing the prevalence of MS report conflicting results due to variation in diagnostic criteria. However, irrespective of the criteria used, it is well accepted that the prevalence of MS is increasing in epidemic proportions in both developed and developing countries. In Latin American populations; Chile, Colombia, Mexico, Peru, Venezuela and Brazil, the prevalence of MS was reported to range between 12.3% to 42.7% depending on the criteria used (Vidigal, Bressan, Babio and Sales-Salvado, 2013).

The prevalence of chronic or non-communicable diseases is escalating more rapidly in the developing countries than in the industrialised countries. According to WHO estimates, by the year 2020, non-communicable diseases will account for approximately three-quarter of all deaths in the developing world (WHO, 1997). Due to the wide diversity in socio-cultural background and different levels of economic and technological development in many countries, as well as increasing economic development in many of the lower to middle-income countries of the world, prevalence of a non-communicable disease such as obesity NDDM and C-V disease has continued to be on the increase. This scenario has evidently led to the increased prevalence of MS worldwide (Ranasinghe, Mathangasignhe, Sayawardena, Hills and Misra, 2017). The problem of obesity in youth is even becoming evident in Nigeria. Indeed, a recent survey comprising 3240 participants revealed childhood and adolescent obesity of 3.2% and 1.8% respectively (Musa, Toriola, Monyeki and Lawal, 2012).

In a systematic review of literature, Ranasinghe *et al*. (2017) reported wide gaps between-country variations in the prevalence of MS in the Asia-Pacific region. For instance data on national surveys from countries such as the Philippines, Pakistan, Malaysia, South Korea, and China were reported. The lowest prevalence of 11.9% (NCEP-ATP III criteria) was reported in the Philippines whereas the highest prevalence of 49.0% was reported in Pakistan in 2004 followed by 37.1% (IDF criteria) from Malaysia in 2008. The most recent prevalence of 31.3% (modified NCEP-ATP III) was reported in 2011-2012 in South Korea. A recent prevalence of 21.3% (NCEP ATP II) was reported from China in 2009.

It has been reported that in most countries about 15% of the adult population or more were affected by MS, and this is comparable with the IDF estimation that nearly one-

quarter of the world's population is affected by MS (IDF, 2016). Data from other regions of the world are presented in Table 2.

Like many other regions, MS is becoming common in Africa with prevalence ranging from as low as 0% to as high as 50% or even higher (Okafor, 2012). In a review of literature, Okafor (2012) reported prevalence rates of MS in some African countries including Nigeria as 15.9 to 36%. Seychelles, 30.9%, Ethiopia, 17.9%; Congo 27.1% and Botswana, 34%.

Table 2: *Prevalence of Metabolic Syndrome in Different Geographical Regions*

Region	Year of publication	Prevalence of MS (%)
Asia – Pacific	2017	11.9 -37.1
Africa	2012	12.5-62.5
Central America	2015	23.0 – 35.1
Europe	2014	11.6 – 26.3
Middle East	2012	13.6 – 36.3
South America	2011	18.8 – 43.3
South Asia	2016	26.1
USA	2013	25.5 – 22.9

Adapted from Ranasinghe *et al*. (2017). BMC Public Health.

Prevalence of MS follows a trend; Africa is no exception: it is apparently higher in the presence of diabetes, obesity, and hypertension with prevalence as high as 80% in diabetics.

Prevalence is also higher in urban than rural areas, and it is more common in females and older individuals (Ulasi, Ijoma and Ondigo, 2010, Njelevela, Mpembeni, Muhihi, *et al*., 2009).

In a comprehensive review of literature, Brambilla *et al*. (2011) reported that of recent, an increasing number of children and adolescents are being affected by MS. For instance, the prevalence of MS is 0.2% in 10-year-old and 1.4% in 15-year-old in Europe, and approximately 4%-7% in US children and adolescents.

Physical Activity in the Management of Metabolic Syndrome

It is well established that a good number of adults and youth are affected by MS (Kessler, Sisson and Short, 2012; Brambila *et al*, 2011). While MS can be treated with medication, it is strongly recommended that lifestyle modification should be the first line approach (WHO, 2010; ACSM, 2009). Most lifestyle intervention programmes include behavioural, dietary and PA components, but evidence exists that regular exercise mitigates cardio-metabolic risk independent of dietary intervention (Carroll and Dudfield, 2004; Ekelund, Anderssen, Froberg, Sardinha, Andersen and Brage 2007). Furthermore, regular exercise also improves cardiorespiratory fitness (Musa, Adeniran, Dikko and Sayers, 2009; Musa, 1998; Musa, 2001), a health benefit that is not expected with a medication-only treatment approach. Research has also demonstrated an association between cardiorespiratory fitness and cardiovascular mortality, as well as all-cause mortality in men and women of all ages (Lee *et al*., 2010; Blair *et al*., 1989). Therefore, there is a strong justification to emphasise exercise within lifestyle improvement programmes that are designed to prevent or treat the MS and its components.

Physical activity intervention in the form of exercise training programmes have been shown to reduce individual heart disease risk factors such as high blood pressure (Musa, Tyoakaa & Ihuma, 2016; Fagard, 2001, Musa and Adeniran, 1996), high plasma lipid and lipoproteins (Durstine, Grandson, Davis, Ferguson, Alderson and Dubose, 2001) high blood glucose (Kelley and Goodpaster, 2001) and reduced HDL cholesterol (Musa *et al*., 2009, Durstine *et al*., 2001).

The WHO (2010) and the ACSM (2009) recommend at least 150 min of moderate - intensity physical activity (40-60% $\dot{V}O_2$max) or 75min of vigorous - intensity PA (60-85% $\dot{V}O_2$max) per week for healthy adults to maintain or improve health. Despite the established benefits of PA, 31.1% of adults worldwide (45% US population) fails to meet the minimum PA guidelines (Hallal *et al*, 2012).

Frequently cited impediments (barriers) to involvement in PA are time constraints, low motivation and poor adherence. Consequently, several investigators have examined the efficacy of high intensity interval training (HIIT) (>85% $\dot{V}O_2$max) to improve or maintain health as an alternative to long duration, continuous, moderate to vigorous intensity PA (Batacan, Duncan, Dalbo, Tucker & Fenning, 2016; Kessler, *et al* 2012; Musa *et al*, 2009). One of the advantages of HIIT compared to lesser-intensity exercise is that it requires less time while providing similar or greater health - related benefits compared to established physical activity recommendations (Ciolac, 2012, Musa *et al*., 2009). HIIT, therefore, can mitigate the most commonly cited barriers to

physical activity which is lack of time. In a meta-analysis, Batacan *et al* (2016) reported that HIIT significantly improved waist circumference, SBP, DBP, $\dot{V}O_2$max in overweight populations but no significant effect in normal-weight populations except for $\dot{V}O_2$max.

Current PA guidelines recommend regular moderate - intensity of a daily minimum of 30 to 60 minutes of brisk walking complemented by other activities. The other activities include gardening, household work, jogging, biking, golfing, swimming, to mention a few. However, a medical examination should precede any exercise programme as there are individuals that must exercise under medical supervision.

If brisk walking is the activity of choice, 500 steps at 3-day interval should be added to a target value of 10,000 - 12,000 steps/day. Prescribing multiple sessions may help individuals recover faster and accumulate a longer duration of exercise. This 30 minutes of exercise achieved in three 10-minute sessions is equivalent to the energy expenditure of 1,500 kcal a week (Haskell *et al*, 2007).

A combination of aerobic and resistance exercise is the best, but any activity is better than none. For individuals who have been sedentary, they need to start with walking and gradually increase duration and intensity. The Centre for Disease Control and Prevention (CDC) and the ACSM define sedentary or physically inactive persons as those who did not engage in at least 150 minutes of physical activities per week (Pate *et al*, 1995). To underscore the benefit of PA in the management and prevention of MS, research has shown that the odds of having MS was almost doubled in adults reporting no moderate or vigorous PA compared with those who engage in at least 150 minutes/week (Ford, Kohl, Mokdad and Ajani, 2005).

Kessler *et al* (2012) in a meta-analysis also observed that HIIT ranging between 2 weeks to 6 months improved aerobic fitness and insulin sensitivity significantly. In their report, a minimum of 12 weeks was necessary for improvement in fasting glucose and a minimum of 8 weeks for improvement in HDL-C. A minimum of 12 weeks was also required for improvement in BP. None of the 17 studies reported improvement in TC, LDL-C or TG. HIIT was also shown to be safe and effective in patients with a range of cardiac and metabolic dysfunction. They concluded that HIIT compared to continuous moderate exercise (CME), appears to promote superior improvements in aerobic fitness and some cardio-metabolic risk factors when performed by healthy subjects or clinical patients for at least 8-12 weeks.

Musa *et al*. (2009) in a study involving young men (21-36-year-old) observed that HIIT of 8-week duration significantly improved aerobic fitness, HDL-C and the ratio

of TC/HDL-C or the atherogenic index. They concluded that HIIT could serve as an alternative mode of exercise to improve lipid profiles for individuals with acceptable physical fitness levels.

An Evidence-Based Relationship between PA and MS in Youth

Findings from both cross-sectional and intervention studies show that PA is a key player in the management of MS. Studies using objective measure of PA (i.e. accelerometer) as well as physical fitness studies have found in healthy children an inverse relationship between PA level and metabolic risk factors independent of age, gender and BMI or obesity (Andersen *et al*., 2006; Ekelund, Anderssen, Froberg, Sardinha, Andersen and Brage, 2007; Rizzo, ruiz, Hurtig-Wennlof, Ortegga and Sjostrom, 2007, Musa, 2019; Musa, 2002).

Some studies also demonstrated that in overweight children, a high fitness level was associated with a risk for MS similar to that of normal - weight children with a low fitness level, thus cancelling out differences between body weight classes and contributing to a long-term prevention (Ortega, Ruiz, Castillo and Sjostrom, 2008, Dubose, Eisenmann and Donnelly, 2007). The preventive role of PA in children's health was demonstrated in a population-based study where a dose-response relationship between PA and BP was found (Mark and Janssen, 2008).

In a study involving 391 Brazillian youths, Neto, de Capos, dos Santos and Junior (2014) concluded that moderate to vigorous physical activity is inversely related to the continuous risk score of MS in adolescents. Furthermore, adolescents should perform at 88 min/day of MVPA to promote healthy metabolic profile.

Intervention studies using obese participants demonstrated that increasing their PA level could reduce MS. Randomised control trials involving children and adolescents have in general found a positive effect on PA programmes, particularly those of moderate-vigorous intensity on blood pressure and lipid levels (Farpour-Lambert, Aggoun, Marchand, Martin, Herrmann and Berghetti, 2009; Kelley and Kelley, 2007).

In a systematic review and meta-analysis, Pattyn, Corhelissen, Saeed, Eshghi, and Vanhees (2013) reported significant reductions in WC (-3.4cm), BP (-7.1 mmHg), and a significant mean increase in HDL-C (+0.06mmol) after dynamic endurance training. Mean plasma glucose levels and TG remained statistically unaltered. Additionally, a significant mean improvement in $\dot{V}O_2$max (+5.9ml) was noted. There were seven studies in all with a total of 206 participants (128 in the exercise group and 78 in the control group).

In a cross-sectional study involving 3243 children (n=1017) and adolescents (n=2226) aged between 9 and 15 years, Musa and Williams (2012) reported that fitness and fatness were independent predictors of resting blood pressure (BP) with fatness being the stronger predictor. Furthermore, both systolic BP and diastolic BP varied by fit-fat group, with the fit-unfat group showing more favourable BP profiles whereas, the unfit-fat group demonstrating the most adverse profiles. They concluded that irrespective of fatness, participants with higher fitness had more favourable BP profiles compared with their unfit peers.

Early Prevention through Physical Activity

The current war against MS can be bolstered by expanding our research efforts into the battlefield of primary or primordial prevention. The enemy is the MS and the major battle field is the fight against physical inactivity. Until recently, the medical community in the management of MS considered diet and pharmacologic treatment as the first approach, whereas physical activity was often considered just a suggestion. Primary prevention was therefore not given the desired attention. The paediatric population was not an exception in this regard. However, scientific evidence collected in the past few years among paediatric subjects support the existence of a strong relationship between PA and MS (Brambilla *et al*, 2011; Adeniran and Musa, 1995, Neto *et al*., 2014; Musa *et al*., 2009, Musa, Toriola and Ibrahim, 2002).

Primary prevention is implemented before the chronic disease is clinically manifested. That is, MS or any chronic disease will never reach its clinical horizon to compromise the health of an individual if it is attacked at its origin to delay or prevent its progression. Preventing chronic disease in the first place is more humane and produces less suffering than treatment or secondary prevention of overt disease. It is also less expensive in terms of health care costs. It is even considered commonsense. For instance, is it not less damaging and expensive for an automobile to undergo routine maintenance and general servicing rather than undergo an engine replacement after several years of neglect?

Primary prevention has been used against non-chronic diseases such as polio, measles, and other infectious diseases with resounding success through vaccination. If primary prevention has been successfully used in the war against other diseases, why not use this strategy against modern chronic diseases, including the MS?

Earlier in the presentation, available evidence in support of the role of physical activity or fitness through cross-sectional, intervention and prospective studies in the prevention and management of MS has been provided. Indeed, it has been observed that, with the exception of diet modification, there is no single intervention with greater promise than physical exercise to reduce the risk of virtually all chronic

diseases simultaneously (Booth *et al*., 2000). In the past couple of decades, Powell and Blair (1994) estimated the public healthcare cost of sedentary lifestyle and reported that physical inactivity and poor diet were responsible for approximately one-third of all deaths due to chronic diseases such as coronary heart disease, colon cancer, and Type 2 diabetes among the Americans. Table 3 details the causes of annual deaths in the United States.

Table 3: *Major Causes of Yearly Preventable Deaths in the United States by Per cent*

Cause	**Estimated Annual Deaths**	**Percentage Preventable Deaths** (%)
Tobacco	400,000	38
Physical Inactivity/Diet	300,000	28
Alcohol	100,000	10
Microbial Agents	90,000	8
Toxic Agents	60,000	6
Fire Arms	35,000	4
Sexual Behaviour	30,000	2
Motor Vehicles	25,000	2
Illicit Use of Drugs	20,000	>2

Source: K.E. Powell & S.N, Blair (1994). Medicine and Science in Sports and Exercise

From the foregoing, it becomes clear that physical inactivity is the major enemy in the battle against MS. The question then is what types of exercise and how can these activities be programmed to effectively keep MS at bay or ameliorate the risk factors? The "magic bullet" is appropriate exercise as it has the ability to positively impact so many risk factors of chronic diseases, including those of MS, prevent and delay the onset of these diseases and enhance longevity and quality of life.

Before going into exercise prescription, it is important to mention the recommendations from some health authorities (American College of Sports Medicine - ACSM; Centre for Disease Control and Prevention - CDC and the American Heart Association - AHA) pertaining to PA and health. In 1995, the ACSM and CDC issued

landmark recommendations on PA and health which were updated in 2007 by the ACSM and AHA as presented below (ACSM, 2018):

- All healthy adults aged 18-65 years should participate in moderate intensity aerobic PA for a minimum of 30 minutes, 5 days per week or vigorous intensity aerobic activity for a minimum of 20 minutes, 3 days per week.
- Above recommendation can be met by performing a combination of moderate and vigorous intensity exercise.
- Moderate intensity aerobic activity can be accumulated to total of the 30 minutes minimal by performing bouts each lasting 10 minutes.
- Every adult should perform activities that maintain or increase muscular strength and endurance for a minimum of 2 days per week.
- Because of dose-response relationship between PA and health, individuals wishing to improve their fitness, reduce chronic disease and disability risks may benefit more by exceeding the minimum recommendations.

In 2008, the American government convened an expert panel, the 2008 Physical Activity Guideline Advisory Committee to review the earlier guidelines based on new scientific evidence. The panel came out with the following recommendations:

- All Americans should participate in moderate intensity PA for 150 minutes per week, 75 minutes per week of vigorous activity, or a combination of both that generate energy expenditure equivalent to either regimen for substantial health benefits.
- Additional health benefits are obtained with 300 minutes per week or more of moderate intensity aerobic activity, 150 minutes per week or more vigorous intensity aerobic activity. This is based on dose-response relationship.
- Adults should engage in muscle strengthening activities that are moderate or high intensity and involve all major muscle groups 2 days per week for additional health benefits.

Exercise Prescription

Exercise prescription has been defined as "the process whereby a person's recommended regimen of physical activity is designed in a systematic and individualised manner" (ACSM, 2014). Visich and Ehrnan (2009) define exercise prescription as "a specific guide provided to an individual for the performance of an exercise training programme". The purpose of exercise prescription is to enhance physical fitness, promote health by reducing the risk for future development or

recurrence of disease and to ensure safety during participation in exercise (ACSM, 2014).

Exercise has many benefits, and because of this, many individuals will want to start exercising. However, there is a need for caution. This is because a sound exercise programme should be prescribed by an exercise scientist or professional with a background in exercise prescription in the same way a physician prescribes medicine to a patient. Before initiating an exercise programme, there are important elements or guidelines to consider, these are highlighted in the presentation that follows.

The recommendations by the 2008 Physical Activity Guideline Advisory Committee can be put into practice by adopting a sound exercise prescription with four basic factors or components as presented by some authorities (Plowman & Smith, 2014; Wilmore, Costill & Kenny, 2008). These factors are: Frequency of participation; Intensity of each exercise bout; Mode (type) of exercise; Duration (time) of each exercise bout; Volume (quantity) of exercise, and Rate of progression (FITT-VP).

Exercise Frequency

Frequency of participation means the number of days in a week an individual engages in exercise. Three to five days a week is the usual recommendation. This does not mean that six or seven days per week will not give additional health-related benefits. Initially, a person should start with 3 days per week. As time goes on and with better adjustment by the body, the frequency can be increased. Ideally, moderate intensity exercise should be performed 5 d/wk while vigorous intensity exercise should be performed 3 d/wk.

Exercise Intensity

Apparently, the intensity of exercise is the most important factor in exercise prescription. Intensity refers to how hard an individual pushes him/herself to gain health-related benefits. The most commonly used method of determining exercise intensity is the heart rate (HR) method. Most authorities recommend between 60% and 90% of maximal heart rate (Plowman and Smith, 2014; Wilmore *et al*.; 2008). The formula for determining an individual maximal HR is: 220 - Age (ACSM, 2014). Evidence suggests that a modest training effect can accrue even with intensity as low as 50% or less. When using heart rate reserve (HRR) or $\dot{V}O_2R$, the light intensity is 30%-40% HRR; moderate intensity is 40%-60% HRR while vigorous intensity is 60%-85% HRR. As with the other factors, training intensity can be increased when much progress is made. Other methods of quantifying exercise intensity include the metabolic equivalent (MET) and the rating of perceived exertion (RPE).

Exercise Mode (Type)
These are the types of activities that are aerobic in nature that can be undertaken for a long period of time. Examples include: walking, jogging, running, hiking, cycling, rowing, rope-skipping, aerobic dance, bench-stepping, and most racket games. Individuals should select activities that they enjoy. Moderate exercise should be accomplished using walking, slow cycling, and slow dancing. Vigorous exercise should be undertaken using jogging, running, stepping, fast cycling and fast dancing. Recreational sports such as racket sports, soccer, basketball, volleyball and hiking are recommended.

Exercise Duration (Time)
Studies have demonstrated that improvement in health-related benefits are possible when activities are undertaken 20 to 60 minutes per exercise session or per day (Wilmore *et al*., 2008). An exercise of moderate intensity should be performed 30-60 minutes per session (≥150 min/wk) while vigorous activities should be performed 20-60 min per session (≥75 min/wk). The frequency can be gradually increased when the individual gets more accustomed and the body has adjusted to the exercise.

Exercise Volume (Quantity)
This refers to the product of frequency *x* intensity *x* time. For adequate health benefits, it is recommended that an individual engaged in moderate-intensity exercise should expend at least 1000 kcal/wk, or pedometer count of ≥5,400 - 7,900 steps per day (see Appendix I for samples of pedometers and accelerometers..

Rate of Progression
During an exercise training programme, physiological and metabolic changes enable the individual to perform more work leading to improvements or progress. However, the rate of progression depends on a person's health status and fitness. In order for improvements to be sustained, the cardiopulmonary and the musculoskeletal systems must be progressively overloaded through periodic increases in frequency, intensity, and duration of the exercise.

Progression has three stages: the initial conditioning stage, the improvement stage, and the maintenance stage. The initial conditioning stage typically lasts 4-6 weeks and serves as a primer to familiarise the client to exercise training. During the first stage, stretching exercises, light calisthenics, and low-intensity aerobics are recommended. Increase in exercise duration of 5 - 10 minutes every 1 - 2 weeks and a slight increase in intensity are reasonable. The improvement stage typically lasts 4 - 6 months and the rate of progression is more rapid. The frequency, intensity, and duration of exercise

should be gradually adjusted upward. The maintenance stage of the exercise programme is for maintaining the level of fitness achieved at the end of the second stage. This stage usually begins six months after the commencement of the exercise programme. During this period, the frequency, intensity, and duration of exercise at the improvement stage should be decreased and other types of exercise such as recreational activities that are enjoyable should gradually replace previous types.

In exercise prescription, a sliding scale can always be applied to suit the individual, that is, if the intensity is low, the duration and frequency can be increased and vice versa. It must be emphasised that before initiating an exercise programme, medical clearance must be obtained, consent for participation secured and initial fitness level of the individual determined. These measures are to prevent legal liability, ensure voluntary participation and ensure individuality.

Exercise Programming

Guidelines for exercise prescription are provided for the apparently healthy, persons with MS and two conditions or components of MS that are commonly found in the adult population. These are hypertension (HTN) and non-insulin diabetes mellitus (NIDDM). The ACSM (2014) has provided comprehensive guidelines which are shown in the tables below:

Risk Classification

Individuals considered for exercise testing or people who wish to increase their PA level are classified into three risk strata (ACSM, 2014):

- Apparently healthy: These are persons who are asymptomatic and look healthy with no more than one major risk factor.
- Individuals at high risk: Those with symptoms suggestive of possible cardiopulmonary or metabolic disease and/or 2 or more major CHD risk factors.
- Individuals with disease: Those with known cardiac, pulmonary or metabolic disease.

Apparently Healthy

The apparently healthy persons (under 45 years) can begin moderate exercise programmes without the need for exercise testing or medical evaluation as long as the exercise programme begins and proceeds gradually and as long as the individual is alert to the development of unusual signs and symptoms. The initial fitness level of the apparently healthy can be determined via field tests, for example, 1 mile walk, 12 minute or 1.5 mile run/walk tests. But for a person above 45 years, it is desirable to

have a maximal exercise test before starting an exercise programme. This also applies to individuals at risk regardless of age. Table 4 details the ACSM recommendations for developing cardio-respiratory fitness in healthy adults.

After undergoing medical and physical fitness evaluation and establishing initial fitness level of clients, the exercise specialist will be in a position to prescribe appropriate exercise. A good adult fitness programme should emphasise aerobic fitness and muscle fitness. Such a programme should comprise four components, namely: warm-up, conditioning (aerobics, resistance, and sports activities), cool-down periods and stretching activities (Table 5). See Appendix II for different types of stretching activities.

Table 4: *ACSM Recommendations for Developing Cardio-respiratory Fitness and Health Promotion in Healthy Adults*

Mode of Exercise
Utilises large muscle groups
Can be maintained continuously
Must be rhythmical
Must be aerobic in nature
Examples include: aerobics, resistance and recreational activities
Intensity of Exercise
30%-40% of HRR or $\dot{V}O_2R$ (light exercise)
60%-90% of (HRR or $\dot{V}O_2R$ (moderate exercise)
60%-85% of HRR or $\dot{V}O_2R$ (vigorous exercise)
Rating of perceived exertion of approximately 12-15 (somewhat hard)
Approximately 60%-70% METs
Duration of Exercise
20-60 minutes of continuous aerobic exercise
Low-intensity exercise should be continued for a longer duration (45-60min)
Moderate-intensity should be continued for 30-60 min
High-intensity exercise should be continued for a shorter duration (20-60min)
Generally, low- to moderate-intensity with longer duration is recommended for most individuals
Frequency of Exercise
3-5 days per week
Moderate-intensity exercise - 5 d/wk
Vigorous-intensity exercise - 3 d/wk

Source: *ACSM (2014). ACSM's Guidelines for exercise testing and prescription*

Table 5: *Components of a Training Programme*

Component	Activities	Recommended time
Warm-up	Stretching, low-level calisthenics, walking	10 minutes
Conditioning	Aerobics: Fast walk, jogging, running, swimming, bicycling, dancing, roller skating, vigorous games Resistance: calithenics, weight training. Sports activities	20-60 minutes
Cool-down	Walking, stretching	5-10 minutes
Stretching	After warm-up and cool-down	10 minutes

Source: *ACSM (2014). ACSM's Guidelines for exercise testing and prescription*

Metabolic Syndrome

According to Donley (2009), most individuals with MS will be overweight, and therefore the exercise prescription should be designed to maximise caloric expenditure. As earlier pointed out, regular physical activity improves several cardiovascular risk factors associated with the MS. Additionally PA is associated with successful weight reduction and maintenance. The exercise prescription for MS will depend largely on the presence and severity of the underlying risks (i.e., obesity, hypertension, diabetes). But because obesity is present in most persons with MS, the exercise prescription guidelines should be based on those for obese patients. In general, because the emphasis of exercise prescription is on weight loss, continuous or intermittent, low to moderate intensity aerobic exercises should be performed initially with the purpose of improving fitness and attaining energy expenditure between 200-400 kcal per session for a period of 6 months. Activities such as brisk walking, swimming and cycling are well tolerated by persons with MS. Table 6 details exercise guidelines for MS patients.

Table 6: *Exercise Programming for Metabolic Syndrome*

Mode	Frequency	Intensity	Duration
Aerobics: Brisk walking, cycling, swimming	5-7 d per week	50-75% HRR or $\dot{V}O_2R$	45-60 minutes
Resistance: 8-10 exercises for major muscle groups	2 d per week	12-15 RM	One set
Flexibility: Static stretching	Post exercise		10-30 s per exercise of each major muscle group

Source: *D. Donley (2009). Clinical Exercise Physiology, Pp. 181-189.*

Hypertension

The ACSM (2009) recommends that people with BP elevations greater than 180/110 mmHg should add endurance training to their drug therapy. Exercise mode should include large muscle, aerobic activities, three to seven days per week, 20-60 minutes per session at an intensity of 50-85% of maximal heart rate. Such training should last between 4 to 6 months (See Table 7). Exercise training of somewhat lower intensity is equally as efficacious or even more particularly when dealing with the elderly or those having other chronic diseases in addition to HTN.

Table 7: *Exercise Programming for Hypertension*

Mode	Goals	Intensity/frequency/duration	Time to goal
Aerobic Large muscle activities	To increase fitness, increase caloric expenditure and control BP	50 – 85% peak HR or 40-60% HRR, RPE of 11-13, 3-7 days/week 30-60 min/session 700 – 2000 kcal/wk	4-6 month
Strength Circuit training	To increase strength	High repetition, low resistance. 2-3 d/wk	

ACSM (2014). ACSM's Guidelines for exercise testing and prescription, pp. 296-299.

Strength or resistance training should never be done as the only form of exercise for hypertensive persons but as a component of a well-rounded programme. Even then, the recommended type is the circuit training. This is because strength training has been consistently shown not to lower BP.

Diabetes

Exercise training is considered by many to be one of the cornerstones of diabetes care. The exercise prescription for people with diabetes must be individualised according to medication schedule, presence and severity of diabetic complications. Food, especially carbohydrate with high glycaemic index must be available during exercise. In addition, there should be adequate consumption of fluid by the individual during and after exercise. Exercise is contraindicated in the following situations:

- If there is eye problem, especially retinal haemorrhage.
- If illness and infections are present.
- If blood glucose is greater than 250 to 300 mg\dl
- If blood glucose is 80 to 10 mg/dl to avoid the risk of hypoglycaemia.
  Table 8 details the exercise programming for diabetics.

Table 8: *Exercise Programming for Diabetes*

Mode	Goals	Intensity/frequency /duration	Time to Goal
Aerobic	To increase fitness	50 to 85% peak HR 40-60% HRR	
Large muscle activities	To increase work capacity To improve BP to reduce blood sugar and other cardiovascular risk factors.	Monitor RPE (11-13) 3-7 days/week 20 – 60 min/session	4 to 6 months
Strength free weights machine weight	To improve strength		4 to 6 months
Flexibility stretching/yoga	To maintain and increase range of motion		4 to 6 months

ACSM (2014). ACSM'S Guidelines for Exercise Testing and Prescription, pp. 278-284

Concluding Remarks

- The risk of MS is related to fatness and it increases from normal weight to obesity in children. The main mechanism underlying MS is insulin resistance.
- There is an increased prevalence of MS worldwide affecting the developed as well as the developing countries.
- While MS can be treated with medication, lifestyle modification, particularly physical exercise has been shown to mitigate cardio-metabolic risks independent of dietary intervention. Additionally, PA improves cardio-

respiratory fitness, a health benefit that is not expected with medication-only treatment approach.

- Research findings have shown that PA is a key player in the management of MS in adults and its prevention in youths. The preventive role of PA in youths has been shown in population-based studies with a dose-response relationship. Primary prevention is warranted due to its major advantage of ensuring better health prospects during adult life.
- Today our society is at war against the ominous enemy, metabolic syndrome. Metabolic syndrome and other chronic diseases confer a heavy burden to society, in terms of medical costs and human suffering. Happily, the physical activity intervention has proven to be a potentially effective component of our arsenal in the war against MS. However, the bad news is that physical activity intervention appears to be the least used weapon in our arsenal.
- In order to fully derive the health benefits of PA in the prevention and management of MS, exercise should be prescribed by specialists focusing on the fundamental guidelines of frequency, intensity, mode, duration, quantity, and rate of progression.

Agenda for Action

- It is important to engage in exercise regularly, and it can take place anywhere there is adequate space, including the house, office, and playfields if available. As much as possible, the individual should engage in natural activities. But if the individual can afford it, obtaining some exercise equipment such as treadmills, cycle ergometers, rowing machines, dumbbells, to mention a few would go a long way to assist the individual.
- Timing of exercise is personal. Some people may find it more convenient in the morning hours, others during lunch break, or in the evenings after official closing hours. Any time of the day is okay as long as environmental conditions are favourable.
- Children and adolescents should participate in ≥60 minutes of moderate to vigorous PA most days of the week, preferably daily. However, it must be noted that there is low compliance with PA recommendations in obese children and adolescents.
- It should be noted that children spontaneously perform short bouts of activities (≤5 minutes) and seldom participate in long-sustained (≥20 minutes) activities. Therefore, intermittent, unstructured and enjoyable activities should be considered.

- We in physical activity profession believe that the medical community underutilises physical activity as an important component of primary prevention of MS and other chronic diseases. As exercise scientists, we believe that the root cause of MS and other chronic diseases generally is physical inactivity. Therefore, there is a need to convince the medical community that MS is rooted in physical inactivity. For this reason, there is a need for synergy between the medical community and exercise scientists to follow a common battle plan and deploy appropriate arsenals to bring MS to its knees.

ACKNOWLEDGEMENTS

First and foremost, I will like to thank the Almighty God who made it possible for me to attain this height in my academic pursuit and also who made it possible for me to be here today for this important event. The glory will always remain His.

Many people have served as my mentors and guardians in the course of my educational and professional voyage. To them, I am very grateful. A philosopher once said: "*We want a learning professor, not a learned professor, one who does not read is not better than one who cannot*". As a learning professor, I am bound to inadvertently omit some vital names on this list of acknowledgements. Please pardon my shortcomings. The Almighty remembers your contribution to my academic and professional development and will surely reward you abundantly.

To start with, let me appreciate you all, the members of this august audience. My colleagues in the Department of Physical and Health Education, the Faculty of Education and the entire University. You are all a source of inspiration to me. Specifically, I will like to appreciate my research collaborators within the University: Professors A.U. Dikko, Badamasi Lawal, Rabiu Mohammed, Mohammed K. Atiku, Sadiq Ismaila and Mohammed S. Fawa. It has been wonderful working with you all. I must also recognise my bosom friends in the non-teaching section of the University: Late Mr. Vincent Aibe, Mr. Maxwell Fwa Farrow, S.K. Amodu and Dr. Fatai Demola Adiatu. You are wonderful. Alhaji Umar Kofar Naisa, you are a friend indeed. Better days are still coming. Alhaji Danjuma Kadiri Ocholi, I cannot thank you enough for your support and generosity. Stay blessed.

As a student and later an exercise physiologist, I learned from notable professionals and friends in academia whose support I must acknowledge. They include: Professor Abel L. Toriola, formerly of OAU and presently at Tshwane University of Technology, South Africa. He introduced me to the wonderful world of the scientific method, during his sojourn as a visiting lecturer in the Department of Physical and Health Education, BUK. He is an academic giant and I remain indebted to him. I must also especially acknowledge my late friend, Professor Ibrahim Adamu Kolo, who though a Special Educationist, made a significant impact on my academic career, particularly in the area of Enquiry Methods. Professor Kolo was an erudite and versatile scholar. Professor Steve Olubadewo, your contribution to my career development in this University is gratefully acknowledged. I also wish to appreciate my course mates at both Master's and Doctoral levels: Professors C.E. Dikki, J.A. Gwani, Ini Jonah, Eta Eta, Bimbo Ayodele, Gerald Thompson, Robert Wood, and Mike Prevost. May you all be blessed.

I want to specifically acknowledge those who served as my career advisors and counsellors over the years. Professor Bisi Adeniran of OAU, a frontline Exercise Physiologist, a friend and mentor, under whom I completed my PhD. To him, I remain grateful. I am also indebted to Professor Mohammed Alfa Chado of ABU, under whom I obtained my Masters degree. I appreciate you Sir. It was a privilege and honour working under the guidance and able leadership of Professor Taoheed A. Adedoja, the foundation Head of Department of Physical and Health Education and a two-term Dean of the Faculty of Education, Bayero University. He was the one who facilitated my appointment into the University and mentored me carefully to acquire the traits required of an accomplished academic. I can hardly find words to thank you Sir. I must not fail to acknowledge the contributions of my other teachers like Professors Kankanala Venkatsurwalu and Bola Adeyanju of ABU; J.T. Ogundari, S. A. Adeyanju and E.B. Okunrotifa of OAU. I appreciate you all.

I must also recognise and appreciate my teachers by proxy. In my academic and professional career, I crossed the paths of some academic giants with whom, I had no face-to-face contact as in a teacher-student relationship, but nevertheless had a significant impact on my development. They include Emeritus Professors Sharon Ann Plowman of the Northern Illinois University, Jack H. Wilmore of the University of Austin, David L. Costill of Ball State University, Edward T. Howley and David Basset of the University of Tennessee, all in the United States of America. I also wish to acknowledge the selfless support that I received from Emeritus Professors William Ross of Simon Fraser University and the late Oded Bar-Or of Laval University, all in Canada. I will ever remain grateful to them.

The contributions of some professors in the United States and United Kingdom with whom I worked during academic fellowships must be duly acknowledged. During my World Bank Junior fellowship at the Louisiana State University, I had the good fortune of working in the Laboratory of Professor B Don Franks, a frontline authority in Adult Fitness and Cardiac Rehabilitation. He served as my PhD Co-supervisor. I appreciate his kindness and generosity. Others in the Department of Kinesiology, at Louisiana State University who made profound contributions to my studies included: Professors Ellen Glickman-Weiss, Arnold Nelson and Richard Magill. At the University of Exeter, my Commonwealth Academic Staff Fellowship afforded me the opportunity to work with eminent professors like Craig A. Williams and Neil Armstrong who are frontline authorities in Paediatric Exercise Science at the Children's Health and Exercise Research Centre. I remain grateful to them.

To my international research collaborators, I thank you all because I learned a lot from you: Professors Abel L. Toriola of the Tshwane University of Technology, Makama A. Monyeki of North-West University, Daniel T. Goon of the University of Forte Hare, and the late Professor Lateef O. Amusa of the University of Venda, all in South Africa. To Professors Steve Sayers of University of Missiouri, USA and Craig Williams of University of Exeter, UK. I wish you all good fortunes in your scholarly endeavour.

To all my students: past, present and future, I remain grateful as you have also been a source of inspiration. Your encouragement and support will not go unrecognised. You will continue to receive the blessings of the Almighty.

I must acknowledge the support, encouragement and the goodwill of my family. I thank God for blessing me with a wonderful, dedicated friend, companion and co-traveller, my wife, Dr. Hadiza Alami Musa who chooses to be a manager rather than a director. I appreciate your love and understanding, and for choosing to manage me effectively. I remain grateful for your kindness and that of our wonderful children.

To my late parents, though not physically present their shining lights continue to glow. I can never forget their care and support. To them, I dedicate my Inaugural Lecture. The late Ibrahim Etila Musa, a First Republic politician, a true friend, supportive and generous father. You will live forever. The late Amina Omeji Ibrahim, a loving and sweet mother whose faith in me shaped my life. Continue to rest in peace. May the Almighty God grant both of you Aljanatul Firdausi, Ameen.

References

ACSM. (2018). *ACSM's Guidelines for exercise testing and prescription* (10th ed.) Philadelphia: Williams & Wilkins.

ACSM. (2014). *ACSM's Guidelines for exercise testing and prescription* (9th ed) Philadelphia: Williams & Wilkins.

ACSM. (2009). *ACSM's Guidelines for exercise testing and prescription* (8th ed) Philadelphia: Williams & Wilkins.

Adeniran, S. A., & Musa, D. I. (1995). Influence of physical fitness on blood in school children. *Journal of Physical Education and Research, 1*(2) 88-90.

Alberti, K.G. & Zimmet, P.Z. (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, *Diabetic Medicine*, *15* (7), 539–553.

Andersen, L.B., Wedderkopp, N., Hensen, H.S., Cooper, A.R. & Froberg, K. (2003). Biological cardiovascular risk factors cluster in Danish children and adolescents: the European Youth Heart Study. *Preventive Medicine, 37*, 363-367.

Andersen, L.B., Harro, M., Sardinha, L.B., Froberg, K., Ekelund, U., Brage, S.. *et al.* (2006). Physical activity and clustered cardiovascular risk in children: A cross-sectional study (The European Youth Heart Study) *Lancet, 368*, 299 -304.

Anderssen, S. A., Cooper, A., Riddoch, C. Andersen, L. B. (2007). Low cardiorespiratory fitness is a strong predictor for clustering of cardiovascular disease risk factors in children independent of country, age and sex. *European Journal of Cardiovascular Prevention and Rehabilitatio,14*, 526-531.

Aziz, F., Al Maskari, F., & Shah, S. M. (2015). Metabolic syndrome among healthy children aged 6 to 12 years in Al Ain, United Arab Emirates. *Pediatrics*, 135, 54.

Balkau, M. A. & Charles, M. A. (1999). Comment on the provisional report from the WHO consultation: European Group for the Study of Insulin Resistance (EGIR), *Diabetic Medicine*, *16*, (5), 442–443.

Batacan, R.B., Duncan, M.J., Dalbo, V.J., Tucker, P. S., & Fenning, A. S. (2016). Effects of high-intensity interval training on cardiometabolic health: A systematic review and meta-analysis of intervention studies. *British Journal of sports Medicine,* 1 - 12.

Beilby, J. (2004). Definition of metabolic syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific issues Related to Definition. *Circulation, 109*, 433 - 438.

Betran-Sanchez, N., Harhay, M.O., Harhay, M. M., & Metlligott, S. (2013). Prevalence and trends of metabolic syndrome in the Adult US population, 1999-2010. *Journal of the American College of Cardiology, 8*, 697-703.

Blair, S.N., Kohl, H.W., & Paffenbarger Jr., R.S. *et al.* (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. *262,* (17), 2395 - 2340.

Booth, G.L. & Wang, E.E. (2000). Preventive health care, 2000 update: Screening and management of hyperhomocysteinemia for the prevention of coronary artery disease events.*Canadian Medical Association Journal, 163*(1), 21-29.

Brambilla, P., Pozzobon, G. & Pietrobelli, A. (2011). Physical activity as the main therapeutic tool for metabolic syndrome in childhood. *International Journal of Obesity, 35*, 16-28.

Brotman, D. J. & Girod, J. P. (2002). The *Journal of the American Medical Association,* Metabolic Syndrome: A tug-of-war with no winner. *Cleveland Clinic Journal of Medicine, 69*(12), 990-994.

Camethon, M.R., Gulati, M. & Greenland, P. (2005). Prevalence and cardiovascular disease correlates of low cardiorespiratory fitness in adolescents and adults. *Journal of the American Medical Association, 294*(23) 2981-88.

Carroll, S. & Dudfield, M. (2004). What is the relationship between exercise and metabolic syndrome abnormalities? A review of the metabolic syndrome. *Sports Medicine, 34*, 374-418.

Caspersen, C.J., Powell, K. E. & Christenson, G. M. (1985). Physical activity, exercise and physical fitness: Definitions and distinctions for health - related research. *Clinical Endocrinology and Metabolism, 16* (4), 595 – 610.

Ciolac, E. G. (2012). High-intensity interval training and hypertension: Maximising the benefits of exercise. *American Journal of Cardiovascular Disease, 2*(2), 102-110.

Clarke, H. H. (1967). *Application of measurement to health and physical education.* Englewood Cliffs, NJ: Prentice Hall Inc.

Cleeman, J. I. (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)," *Journal of the American Medical Association*, *285* (19), 2486–2497.

Cornier, M. A. *et al.* (2008). The metabolic syndrome. *Endocronological Review, 29* (7), 777 – 822.

Donley, D. (2009). Metabolic syndrome. In. J.K. Ehram, P. M. Gordon, P. S. Visich & Keteyian, S. J. (Eds.), *Clinical Exercise Physiology*(2nd ed., pp. 181-189). Champaign, IL: Human Kinetics Books.

Dubose, K. D., Eisenmann, S. C. & Donelly, J. E. (2007). Aerobic fitness attenuates the metabolic syndrome score in normal-weight, at-risk-for- overweight and overweight children. *Pediatrics, 120,* e1262- e 1268.

Durstine J. L., Grandjean, P.W., Davis, P.G., Ferguson, M.A., Alderson, N.L. & Dubose, K. D. (2001). Blood lipid and lipoprotein adaptations to exercise: A quantitative analysis. *Sports Medicine*, 31, 1033 - 1062.

Einhorn, D. Reaven, G. M., Cobin, R. H. *et al.* (2003). American College of Endocrinology position statement on the insulin resistance syndrome, *Endocrine Practice*, *9* (3), 237-252, 2003.

Eisenmann, J.C., Dubose, K. D. & Donnelly, J. E. (2009). Fatness, fitness and insulin sensitivity among 7-to-9-year-old children. *Obesity, 15*, 2135 – 2144.

Ekelund, U., Anderssen, S. A., Froberg, K., Sardiuha, L. B., Andersen, L.B., & Brage, S. (2007). Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: The European youth heart study. *Diabetologia, 50,* 1832 – 1840.

Fagard, R.H. (2001). Exercise characteristics and blood pressure response to dynamic physical training. *Medicine and Science in Sports and Exercise 33,* 5454 – 5492.

Farpour-Lambert NJ, Aggoun Y, Marchand LM, Martin XE, Harrmann FR & Beghetti M (2009). Physical activity reduces systemic blood pressure and improves early markers of atherosclerosis in prepubertal obese children. *Journal of the American College of Cardiology, 25,* 2396 – 2406.

Ford, E.S., Kohl III, H.W., Mokdad, A.H. & Ajani, U. (2005). Sedentary behaviour, physical activity and metabolic syndrome among US adults. *Obesity Research, 13*(3), 608-614.

Garcia-Artero, Ortega, F.B., Ruiz, J.R., Mesa, J.L., Delgado, M., Gonzalez-Gross, M, et al. (2007). Lipid and metabolic profiles in adolescents are affected more by physical fitness than physical activity (AVENA-Study). *Review Esp. Cardiology, 60*(6) 581 – 588.

Global, M.S. (2012). High-intensity in interval training and hypertension: maximising the benefits of exercise. *American Journal of Cardiovascular Diseases, 2*, 102 – 110.

Hallal P.C., Andersen, L.B., Bull, F.C. *et al.* (2012). Global physical activity levels: Surveillance progress pitfalls and prospects. *Lancet, 380*, 247 – 257.

Haskell, W.L., Lee, I-M, Pate, R.R. *et al.* (2007). Physical activity and public health. Updated recommendations for adults from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1081 – 1093.

Holloszy, J.O. (2005). Exercise-induced increase muscle insulin sensitivity. *Journal of Applied Physiology, 99*, 338 – 343.

Howley, E.T. & Franks, D.B. (1997). *Health fitness instructor's handbook*. Champaign, IL: Human Kinetics.

IDF (2005). The IDF Consensus worldwide definition of the metabolic syndrome. 2015, 16/9/2016); Available from: http://www.idf.org/metabolic-syndrome. Accessed 25 Dec. 2016.

IDF (2016). Worldwide trends in diabetes since 1980: A pooled analysis of 751 population-based studies with 4.4 million participants. *The Lancet*,

Kashyap, S.R. & Fronzo, R.A. (2007). The Insulin Resistance Syndrome: Physiological considerations. *Diabetes Vascular Disease Research*, 4, 13-19.

Kaur, J. (2014). A comprehensive review on metabolic syndrome. *Cardiology Research and Practice*, 2014, 1-21.

Kelishadi, R. (2007). Childhood overweight, Obesity, and the metabolic syndrome in developing countries. *Epidemiological Reviews, 29*, 62 – 76.

Kelley, D. E. & Goodpaster, B. H. (2001). Effect of exercise on glucose homeostasis in Type 2 diabetes mellitus. *Medicine and Science in Sports and Exercise*, *33*, 5495 – 5501.

Kelley, G. A. & Kelley, K. S. (2007). Aerobic exercise and lipids and lipoproteins in children and adolescents: A meta-analysis of randomised controlled trials. *Atherosclerosis, 191*, 447 – 453.

Kessler, H. S., Sisson, S. B. & Short, K. R. (2012). The potential of high - intensity interval training to reduce cardiometabolic disease risk. *Sport Medicine, 42*(6), 489-509.

Kullo, I., Hensrud, D. D. & Allison, T. G. (2002). Relation of low cardiorespiratory fitness to metabolic syndrome in middle - aged men. *American Journal of Cardiology*, 90, 795 - 797.

Lakka, T.A., Lolaksonen, D. E. & Lakka, H. M. (2003). Sedentary lifestyle, poor cardiorespiratory fitness and the metabolic syndrome. *Medicine and Science in Sports and Exercise, 35*, 1279 – 1286.

Lee, D.C., Artero, E.G., Suix, *et al.* (2010). Mortality trends in the general population: The importance of cardiorespiratory fitness. *Journal of Psychopharmacology, 24*(4suppl.) 2735).

Lee, S.J. & Arslanian, S.A. (2007). Cardiorespiratory fitness and abdominal adiposity in youth. *European Journal of Clinical Nutrition, 62*, 561 – 565.

Mark, A. E. & Janssen, I. (2008). Dose-response relation between PA and blood pressure in Youth. *Medicine and Science in Sport and Exercise, 40*, 1007 – 1012.

McMurray, R.G., Bangiwala, S.I., Harrell, S.S. & Amorim, L.D. (2008). Adolescents with metabolic syndrome have history of low aerobic fitness and physical activity levels. *Dynamic Medicine*, doi: 10. 1186/ 1476-5918-7-5.

Musa, D.I., Angba T. & Bamidele, B.B. (2019). Cardiorespiratory fitness in relation to adiposity in 9-17 year-old Nigerian youth. *Gazzetta Medica Italiana*. (In press).

Musa, D.I., Tyoakaa, A. A. & Ihuma, J. (2016). Influence of aerobic fitness on blood pressure and body fat in children and youth in Benue north west senatorial district of Benue State. *Journal of Health and Human Kinetics, 1*(1) 54 - 64.

Musa, D.I. & Williams, C.A. (2012). Cardiorespiratory fitness, fatness and blood pressure associations in Nigerian youth. *Medicine and Science in Sports and Exercise, 44*(10), 1978-1985.

Musa, D.I., Toriola, A.L., Monyeki, M.A. & Lawal, B. (2012). Prevalence of childhood and adolescent overweight and obesity in Benue State, Nigeria. *Tropical Medicine and International Health, 17* (11), 1369-1375.

Musa, D.I., Adeniran, S.A., Dikko, A.U. & Sayers, S.P. (2009). The effect of high intensity – interval training program on high density lipoprotein cholesterol in young men. *The Journal of Strength and Conditioning Research, 23*(2) 587 – 592.

Musa, D.I. (2003). Prevalence of coronary heart disease risk factors in pre-adolescence female school children in Kano city: A preliminary investigation. *Journal of the Nigerian Women in Sports, 2*(1), 9-18.

Musa, D.I., Ibrahim, D.M. & Toriola, A.L. (2002). Cardiorespiratory fitness and risk factors of coronary heart disease in pre-adolescent school girls. *Journal of Human Movement Studies, 42*, 455 – 465.

Musa, D.I. (2002). Effect of 8-week jogging programme on the body fat in untrained women. *African Journal for Physical, Health Education, Recreation and Dance, 8*(1), 37 – 48.

Musa, D.I. (2001). Effects of continuous and intermittent training programmes on aerobic fitness: And overview. *Journal of Health Education and Sport Science,* 2(2), 128 – 142.

Musa, D.I. (1998). Influence of 8-week aerobic training on abdominal fat reduction in male university students. *Nigerian School Health Journal, 1*(2), 147 – 154.

Musa, D.I. (1997). The effect of physical training in aerobic fitness and selected risk factors for coronary heart disease in female undergraduate students. *Women and Education, 2*(1), 182 – 195.

Musa, D.I. & Adeniran, S.A. (1996). Effects of different running programmes on VO^2max and blood pressure in college men. *Journal of Research in Health and Sports Science*. 1(2), 65-70.

Neilsen G. A. & Andersen L. B (2003). The association between high blood pressure, physical fitness and body mass index in adolescents. *Preventive Medicine, 36* (2), 229 – 234.

Neto, A.S., de Campus, W., dos Santos G.C. & Junior O.M. (2014). Metabolic risk score and time expended in moderate to vigorous physical activity in adolescents. *BMC Paediatric 14*, 42.

Nieman, D.C. (2003). *Exercise testing and prescription: A health-related approach* (5th ed.). Boston, MA: McGrawHill Higher Education.

Njelevela, M.A., Mpebmbeni, R., Muhihi, A. *et al.* (2009). Gender - related differences in the prevalence of cardiovascular disease risk factors and their correlates in urban Tanzania. *BMC Cardiovascular Disorders, 9*, 30.

Okafor, C.I. (2012). The metabolic syndrome in Africa: Current trends. Indian *Journal of Endocrinology and Metabolism, 16(1),* 56 – 66.

Ortega, F.B., Ruiz, J.R., Castillo, M.J. & Sjostrom, M. (2008). Physical fitness in childhood and adolescence:A powerful marker of health. *International Journal of Obesity, 32,* 1-11.

Pate, R.R., Pratt, M., Blair, N. et al. (1995). Physical activity and public health: A recommendation from the centre for disease control and prevention and the American college of sports medicine. *Journal of the American Medical Association, 273* (5), 402 – 407.

Pattyn, N., Corneliseen, V.A., Saeed, R., Eshghi, T. & Vanhees, L. (2013). The effect of exercise on the cardiovascular risk factors constituting the metabolic syndrome. *Sports Medicine, 43*, 121 – 133.

Physical Activity Guidelines Advisory Committee (2008). Physical activity guidelines advisory committee report, Washington DC: Us Department of Health and Human Services.

Plowman, S.A. & Smith, D.L. (2014). *Exercise physiology for health, fitness and performance* (4th ed.). Philadelphia: Lippincott Williams and Wilkins.

Powell, K.E. & Blair, S.N. (1994). The public health burden of sedentary living habits: Theoretical but realistic estimates. *Medicine and Science in Sports and Exercise, 26*, 851-856.

Ranasinghe, P, Mathangasinghe, Y, Dayawardena, R, Hills, AP & Misra, A. (2007). Prevalence and trends of metabolic syndrome among adults in the Asia – Pacific region: A systematic review. *BMC Public Health, 17*, 101.

Reaven, G.M. (2006). The metabolic syndrome: Is this diagnosis necessary? *American Journal of Clinical Nutrition, 83*, 1237 - 1247.

Rizzo, N.S., Ruiz, J.R., Jurtig-Wennlof, A., Ortega, F.B. & Sjostrom, M. (2007), Relationship of physical activity, Fitness and fatness with clustered metabolic risk in children and adolescents: The European heart study. *Journal of Pediatrics, 150*, 388 – 394.

Robergs, R.A. & Keteyian, S.J. (2003). Fundamentals of exercise physiology for fitness performance and health (2nd ed.) New York: McGraw-Hill Higher Education.

Sarafidis, P.A. & Nilsson, P.M. (2006). The metabolic syndrome: A glance at its history. *Journal of Hypertension, 24*(4), 621 – 626.

Ulasi, L.L., Ijoma C.K. & Onodugo O.D. (2010). A community- based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC Health Services Research, 10*:71.

Vidigal, F.D.C, Bressan, J, Babio, N, & Salas-Salvado, (2013). Prevalence of metabolic syndrome in Brazilian adults: A systematic review. *BMC Public Health, 13*, 1198 – 1207.

Visich, P.S. & Ehrman, J.K. (2009). Graded exercise testing and exercise prescription. In. J.K. Ehram, P.M. Gordon, P.S. Visich & Keteyian, S.J. (Eds.), *Clinical Exercise Physiology* Champaign, IL: Human Kinetics Books. . *2* 77-108.

Whaley, M.H., Kampert, J.B., Kohl, H. & Blair, S.N. (1999). Physical fitness and clustering of risk factors associated with the metabolic syndrome. *Medicine and Science in Sports and Exercise, 31*, 287-293.

WHO (1997). Global strategy for non-communicable disease prevention and control (draft). Geneva, Switzerland WHO (Publication no. WHO/NCD/GS/97.1).

WHO (2010). WHO Global Recommendations on Physical Activity for Health. Geneva: WHO.

Wilmore, J.H., Costill, D.L. & Kenney, W.L. (2008). *Physiology of Sport and Exercise (4th)*. Champaign, IL: Human Kinetics.

APPENDIX 1

PHYSICAL ACTIVITY MOTION SENSORS

A. Pedometers

B. New-Lifestyles NL-Series Accelerometers

LIFECORDER EX
Steps, Activity Kcals, Total Kcals, 200-Day Memory, Clock, & Software from $29

LIFECORDER PLUS
Steps, Activity Kcals Total Kcals, 60-Day Memory, Clock, & Software

NL-1000
Steps, Distance, MVPA™ Timer, 7-day Memory & Clock from $54.95

NL-800
Steps, 7-day Memory & Clock
from $49.95

New, 3-D NL-2000i
Steps, Distance, MVPA™ Steps & Time, 7 or 14-day Memory & Kcals Comes in Rojo Red, Silver, Blue and Deep Red. from $69.95

C. ***Digi-Walker Sw-Series Coiled-Spring Pedometers***

SW-701
Steps
Distance & Kcals
from $29.95
CW-300 (*Special

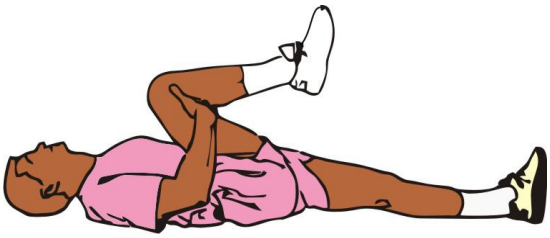
SW-651
Steps,
Distance, Stopwatch & Clock from $29.95*

SW-401
Steps & Distance
in yellow or black
from $24.95

SW-200
Steps Only
in yellow or black
from $19.95

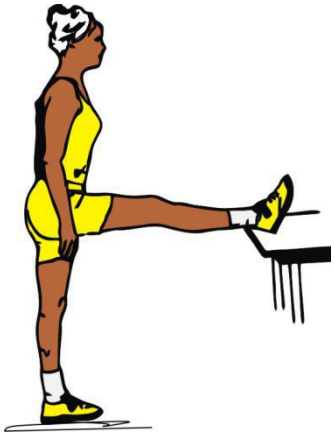
APPENDIX 1I

SOME FLEXIBILITY EXERCISES



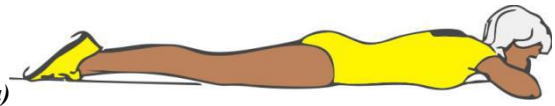
Posterior Pelvic Tilt

Step/Chair Stretch

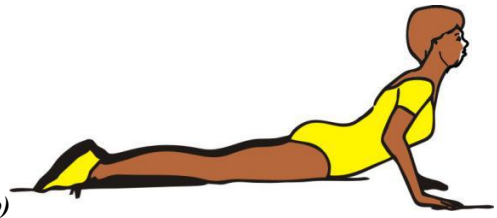


Trunk Extension Exercise

(a)

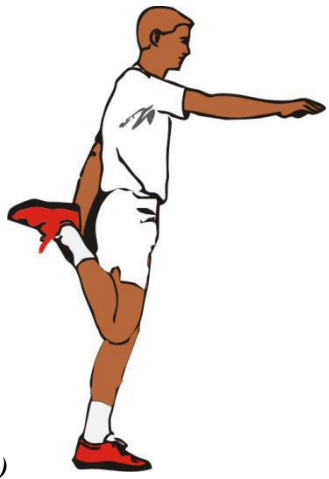


(b)

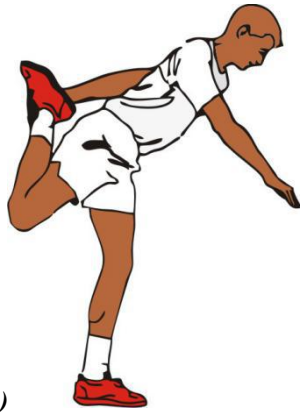


Hip Flexor Stretch (Standing)

(a)



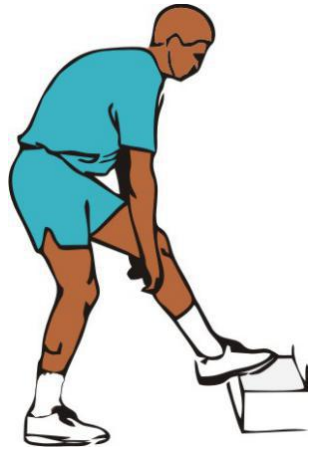
(b)

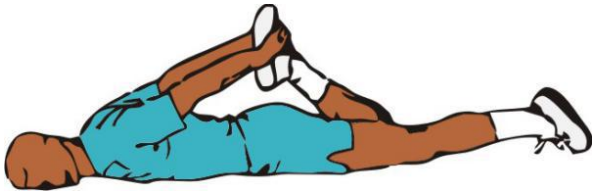


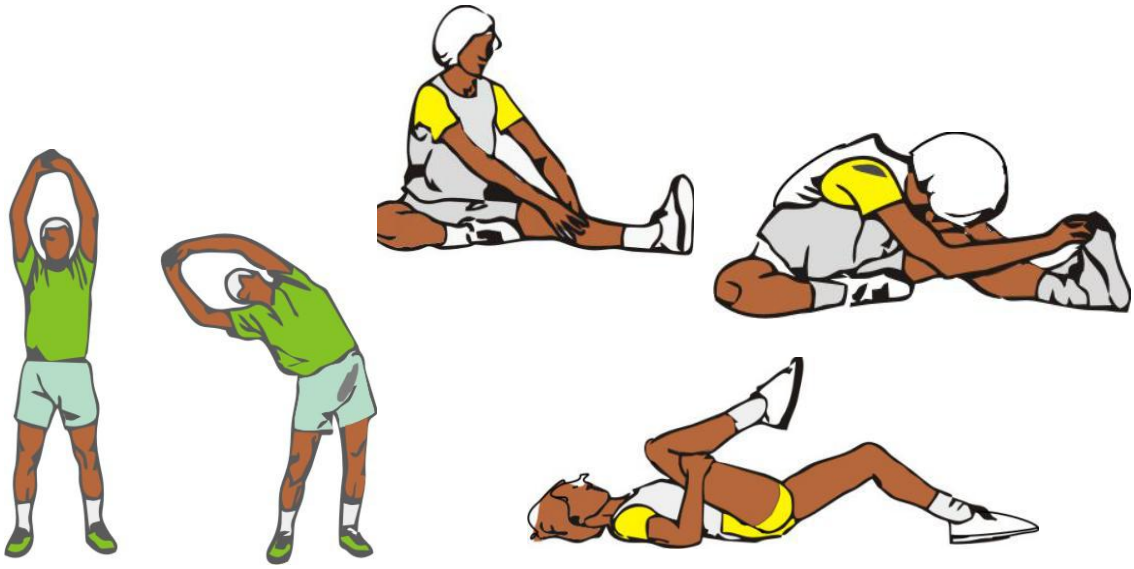
Crunch Partial Curl

(a)

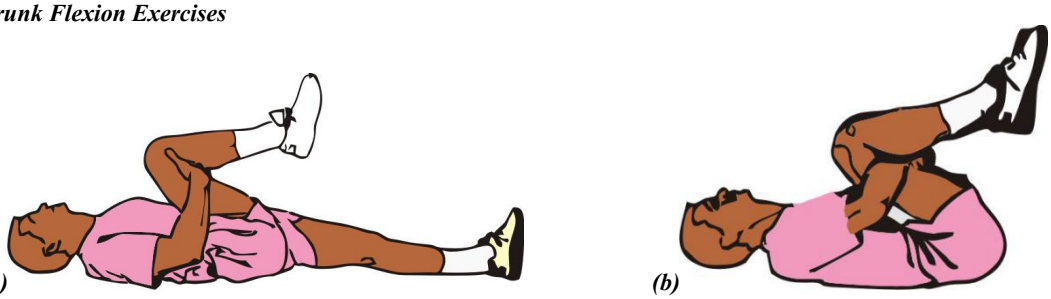
(b)







Trunk Flexion Exercises



(a) ***(b)***

APPENDIX III
LIST OF PROFESSORIAL INAUGURAL LECTURE TO DATE

S/N	NAME	DEPT	DATE	TOPIC
1st	Emmanuel Ajayi Olofin	Geography	4th March, 1992	The Gains and Pains of Putting a Water Lock on the Face of the Drylands of Nigeria
2nd	Garba Dahuwa Azare	Education	24th June, 2000	BASIC CONCERNS: Revitalizing Nigeria's Primary Education in the New Millennium
3rd	Dajuma Abubakar Maiwada	Education	29th July, 2000	Improving Teaching and Learning in University Education with Particular Reference to Bayero University, Kano
4th	Majekodunmi Oladeji Fatope	Chemistry	7th July, 2001	NATURAL PRODUCTS SCIENCE: Looking Back and Looking Forward
5th	Muazu Alhaji Zaria Sani	Nigerian Languages	13th October, 2001	A focus on Some Segmental and Suprasegmental Features in Hausa Phonology
6th	Isa Hashim	Political Sciences	20th March, 2004	Planning and Budget Implementation in the Health Sector
7th	Abdulla Uba Adamu	Education	24th April, 2004	SUNSET AT DAWN, DARKNESS AT NOON: Reconstructing the Mechanisms of Literacy in indigenous Communities
8th	Auwalu Hamisu Yadudu	Private and Commercial Law	5th June, 2004	LAW AS INTERPRETATION: An Exploratory inquiry from Islamic Law Jurisprudence
9th	Mohammed Sanni Abdulkadir	History	31st July, 2004	STRUCTURING, STRUGGLING AND SURVIVING ECONOMIC DEPRESSION IN NORTHERN NIGERIA: The 1930s As Preview of the present

S/N	NAME	DEPT	DATE	TOPIC
10th	Muhammad Sani Sule	Bio-chemistry	23rd March, 2013	Enzymology and Radiation Biology in the Understanding of Biochemistry
11th	Essiet Unanaowo Essiet	Agriculture	22nd May, 2013	AGRICULTURE SUSTAINABILITY IN THE DRYLAND OF NIGERIA: Realities and Prospects
12th	Aliyu Kamal	English Studies	5th March, 2014	The Islamic Novel Style and Structure
13th	Abdu Ahmed Manga	Agriculture	9th April, 2014	Horticulture as a Panacea for Food Insecurity and Unemployment
14th	Sa'idu Muhammad Gusau	Nigerian Languages	26th May, 2014	Wakar Baka Bahaushiya (The Hausa Oral Songs)
15th	Abdulla Uba Adamu	Mass Comm-unication	9th July, 2014	IMPERIALISM FROM BELOW: Media Contra-Flows and Emergence of Metro-Sexual Hausa Visual Culture
16th	Ghaji Abubakar Badawi	Library and Information Sciences	29th July, 2015	THE ROLE OF PUBLIC LIBRARIES AS CENTERS OF INFORMATION TO DISADVANTAGED GROUPS: A 2004 - 2014 Study of the Information Needs of Gada Prostitutes in Dawakin Kudu Local Government Area of Kano State, Nigeria.
17th	Mohammed Kabir	Community Medicine	16th September, 2015	Public Health Concern for Chronic Non-Communicable Diseases Surpasses Anxiety Over Most Infections
18th	T.I. Oyeyi	Biological Sciences	30th March 2017	Linking Schistosomiasis and Water Resources Development in Kano State Nigeria: Public Health Impact and Mitigation

S/N	NAME	DEPT	DATE	TOPIC
19th	Abdulrazaq G. Habib	Medicine	27th April, 2017	Medicine, Science and Society – The Global Health Imperative
20th	S. Y. Mudi	Chemistry	6th July, 2017	Natural Products: Plants as Potential Sources of Drugs
21st	Sani Ibrahim	Biological Sciences	27th July, 2017	BETWEEN LIFE AND DEATH: Water Quality and Resource Evaluation - The Place of Hydrobiologists
22nd	J. Afolabi Falola	Geography	26th October, 2017	The Poor We Always Have With Us
23rd	U.G. Danbatta	Electrical Engineering	2nd November, 2017	GETTING OUT OF THE WOODS: Diversifying Nigeria's Economy Through the Telecommunications Sector
24th	Adelani W. Tijani	Nursing	23rd November, 2017	Wholesome Alimentation: Path to Radiant Health
25th	Juwayriya Badamasiuy	Private and Commercial Law	21st December, 2017	Uncovering Patriarchy in the Law: Feminist Movement for Re-Interpretation of Islamic Law in Focus.
26 th	Isa Mukhtar	Nigerian Language	25th January, 2018	STYLISTIC THEORIES AND THE LINGUISTICS OF HAUSA PROSE TEXTS: the (SFL) approach.
27th	Ganiyu Sokunbi	Physiotherapy	29th March, 2018	Today it hurts, Tomorrow it works Complimentary & Alternative Therapy for Failed Back Syndrome
28th	Aminu K. Kurfi	Business Administration and Entrepreneurship	19th April, 2018	Micro-finance as an Elixir for Poverty Alleviation and Wealth Creation in Nigeria

S/N	NAME	DEPT	DATE	TOPIC
29th	Muhammad Sani Khamisu	Arabic	17th May, 2018	Substitution in Arabic Languages Rule and Types
30th	Habu Nuhu Aliyu	Pure and Industrial Chemistry	21st June, 2018	SCHIFF BASES AND THEIR TRANSITION METAL COMPLEXES: The Drug for the Next Generation
31st	Hashim Mohammed Alhassan	Civil Engineering	19th July, 2018	EASING THE BURDEN OF TRAVEL: Can Roadway Capacity Modeling Help?
32nd	Habu Mohammed	Political Science	13th September, 2018	TUG OF WAR OR ECHO IN THE DARK? Civil Society Organizations (CSOs) and the Fight Against Corruption in the Era of Change Mantra in Nigeria
33rd	Bello Idrith Tijjani	Physics	20th September, 2018	NAVIGATING THE DATA LABYRINTH: Application of Some Advanced Statistical Analysis in Atmospheric Physics
34th	Mohammed Ajiya	Electrical Engineering	18th October, 2018	SEAMLESS GLOBAL CONNECTIVITY AT THE SPEED OF LIGHT: Converting Intrinsic Phenomena in Optical Fibers to Capacity Increase.
35th	Abdulrahman Abdul Audu	Pure and Industrial Chemistry	25th October, 2018	MY ACADEMIC VOYAGE IN WATER INTO THE WORLD OF HEAVY METALS
36th	Ibrahim Rakson Muhammad	Animal Science	21st February, 2019	FORAGE AND FODDER PRODUCTION IN NIGERIA: Its Sensitivity in Sustainable Ranching.

S/N	NAME	DEPT	DATE	TOPIC
37th	Muhammad Bashir Ibrahim	Department of Pure and Industrial Chemistry	14th March, 2019	WATER POLLUTION AND THE QUEST FOR ITS REMEDIATION: The Natural Resource Option
38th	Oyerinde Olufemi Oyesegun	Department of Physical and Health Education,	4th April, 2019	MAN DOES NOT DIE BUT KILLS HIMSELF: The Dilemma of the Health Educator and the Moderating Influence of Health Education
39th	Danladi Ibrahim Musa	Department of Physical and Health Education	25th April, 2019	WAGING WAR ON THE DEADLY QUARTET AND ITS CO-MORBIDITIES: A Physical Activity Panacea