



Cardiovascular Health and Physical Activity for Sustainable National Development

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Abstract

This paper discussed cardiovascular health and Physical Activity (PA). It focused on Coronary Health Disease (CHD) and stroke (Cerebrovascular Disease (CVD)). The paper discussed how PA benefits induce cardiovascular health (CHD and CVD). It revealed that engagement in PA enhance cardiovascular health and well-being by preventing the onset and development of several cardiovascular and non-cardiovascular diseases (CHD, CVD, diabetes, Cancer, etc.). The paper established that PA, that are regularly performed at moderate-vigorous intensities reduces risk factors for cardiovascular disease, and that even low intensity PA produce multitude of benefits for cardiovascular health, over-all health and well-being of participants by; lowering blood pressure, decreasing levels of total and low density lipoprotein (LDL) cholesterol, increasing high density lipoprotein (HDL) cholesterol, etc. Mechanisms through which PA-induced benefits impact cardiovascular health by inducing changes in oxygen delivery, improving vasculature and myocardial perfusion, improving mitochondrial biogenesis and function, enhancing inter-tissue communication through release of myokines, among others were also discussed. Impacts of PA-induced benefits on SDGs, where healthy and fit Nigerians would end poverty everywhere, end hunger, ensure healthy lives and well-being, ensure quality education, achieve gender equality, among others. were highlighted. The paper concludes that PA is an important therapeutic remedy for CHD and CVD patients as it improves their endothelial-dependent vasodilation, increase their ejection fraction and improve their quality of life and well-being, among others. The paper recommends that individuals (male or female) should make regular PA participation a habit for fitness and health gains, and that the elderly (70 years and above) to engage in low intensity exercise (brisk-walking, gardening, stair-case climbing, etc.) for optimal health and well-being.

Keywords: Cardiovascular Health, Physical Activity and Sustainable National Development.

Introduction

Physical activity (PA) seems to be one of the most used buzzword when it comes to its use to improve health and prevent diseases among individuals. For the purpose of this paper, PA can be seen as any bodily movement from skeletal muscles that result in energy expenditure compared to resting state (Wamukoya, Muchiri & Oloo, 2019). They pointed out that exercise is a subcategory of PA that is planned, structured and repetitive for the purpose of conditioning any part of the body or the body as a whole. As a result of the similarity of the two terms, they will be used interchangeably in this paper to mean the same thing.



Evidence from numerous studies have shown that engagement in regular PA enhance good health and longevity of life for the participants. It has severally been documented that participation in regular PA can prevent the onset and development of several chronic diseases, as well as serving as an important therapeutic tool to improve outcomes for patients with cardiovascular diseases such as coronary heart diseases (CHD) and stroke (Cerebrovascular diseases (CVD) (Hegde & Solomon, 2015). Similarly, regular PA participation has several beneficial effects on overall health of the individual such that, it decreases markers of inflammation, improves metabolic health, decreases risk of heart failure and improves overall survival of participants (Che & Li, 2017; Nystoriak & Bhatnagar, 2018).

Studies have shown too that PA that is regularly and moderately-vigorously performed has the properties for reducing risk factors for CHD and CVD. The benefits of PA participation to human beings cannot be over emphasized, as a result, its roles as part of healthy lifestyles can only be appreciated. Therefore a planned exercise programme which is, as earlier pointed out, a subset of PA, will improve cardiovascular parameters such as maximal oxygen consumption ($\dot{V}O_2$ max), cardiac output (\dot{Q}), stroke volume (SV), heart rate (HR), among others; adding that a higher $\dot{V}O_2$ max is associated with low death rate from cardiovascular diseases (Hedge & Solomon, 2015).

It was also revealed that PA that is performed at low intensity is equally beneficial for reducing CHD and CVD (Piepoli, Hoes, Agewell, Albus, Brotons, catapano, et al, 2016). They pointed out that the reduction in the risk factors for CHD and CVD due to low intensity PA may be mediated by changes in the distribution of cholesterol or an increase in fibrinolysis. It's no surprise then that the American College of Sports Medicine (ACSM)'s Guideline for Exercise Testing and Prescription re-emphasized the need for low intensity exercise such as brisk-walking, gardening, stair-case climbing etc, throughout one's lifetime. According to the ACSM's Guidelines, such a recommendation is consistent with exposing the general public to low risk PA to achieve health related benefits aimed at reducing cardiovascular and other metabolic health challenges.

Recent studies have shown too that exercise participation also reduce the development of Type 2 diabetes by improving glucose tolerance, insulin sensitivity and decrease circulating lipid concentration (Pinckard, Baskin & Stanford, 2019). They stressed that this occur primarily through adaptations to the skeletal muscles, liver and adipose tissues; adding that regular exercise decrease not only cardiac output, stroke volume, resting heart rate, blood pressure and other organic markers, but also increases physiological cardiac hypertrophy. Again, frequent PA participation improves myocardial perfusion and increase high-density lipoprotein (HDL) cholesterol levels, all of which reduces stress on the heart and improves cardiovascular functions in aging, healthy and diseased individuals (Che & Li, 2017).

Given the increasing interest in exercise-based therapies, attention is also given to the mechanisms through which PA-induced benefits influence cardiovascular health. The paper also discussed the impact of PA-induced benefits on sustainable development goals in Nigeria. The purpose of this paper is to discuss ways by which participation in PA promote cardiovascular health (CHD and CVD) of the citizens of this country. Such ways include; reduces the risk of people dying prematurely, lowers high blood pressure, prevents the development of diabetes ,



enhances mitochondrial functions, reduces or maintains body weight, reduces low density lipoprotein (LDL) cholesterol, increases high density lipoprotein (HDL) cholesterol, reduces stress and anxiety, improves mood and depression, among others (Elmagd, 2016; Nystoriak & Bhatnagar, 2018; Pinckard et al, 2019).

Physical Activity for Sustainable National Development

Physical activities (PA) have been defined earlier in this paper. Efforts to understand how PA participation promote or enhance cardiovascular health lead scientists to investigate how PA participation decreases the individual's cardiovascular disease risk factors. Such studies were mainly on the effects of PA on diabetes mellitus, hypertension, obesity, hypercholesterolemia, high blood pressure, among others (Arija & Villalobos, 2017). They stressed that several studies have shown that PA reduces high blood pressure, adding that blood pressure is controlled by decreasing adrenergic tone, diminishing levels of circulating catecholamine levels, decreasing total peripheral resistance, decreases insulin resistance, decreases body fat and body weight, and increases better functional capacity of peripheral pump.

Evidence of protective effects of PA on health outcome has been apparent since the origin of modern medicine. It has been pointed out that Hippocrates was referring to PA when he stated that "all the parts of the body has function if used in moderation and exercised in labour in which each is accustomed, becomes thereby healthy, well developed and age more slowly, but if unused and left idle, they become liable to disease, defective in growth, functions and age quickly". Such is the case with the human body which if left in inactivity for long, would not only become clumsy and defective in its functions, but would also be stiff, uncoordinated, lack stamina and fatigue easily when involved in exercise and age quickly.

Benefits of Physical Activity for Sustainable National Development

The benefits derived from PA participation by participants are enormous, particularly when such activities are performed on a regular basis. Such regular exercise apart from decreasing overall mortality makes the heart stronger and the lungs fitter thus enabling the cardiovascular system to deliver more oxygen to the heart, with every beat, and the pulmonary system to increase the maximum amount of oxygen that the lungs can take in and send to the heart for distribution round the body (Fiuza-Luces, Santos-Lozano, Joyner, Carrera-Bastos, Picazo, Zugaza, et al, 2018; Pinckard et al, 2019).

PA participation produces multitude of benefits for cardiovascular health, overall health and well-being of participants. Exercise participation lowers blood pressure, decrease the level of total and low-density lipoprotein (LDL) cholesterol, and increase the level of high-density lipoprotein (HDL) cholesterol (Piepoli et al, 2016). These helpful effect decrease the risk of heart attack (CHD) and stroke (CVD) by lowering cholesterol levels and making the heart to pump blood more efficiently and reduces the risk of dying prematurely especially of heart diseases, helps also to control body weight and prevent obesity which is also among the risk factor for high blood pressure and diabetes (Green, Hopman, Padilla, Laughlin & Thijssen, 2017; Fiuza-Lucas et, 2018).



It was also stressed that regular exercise performance improves mood, reduces stress and relieves depression, builds muscular strength and tones, increases flexibility and enhance endurance, stressing that just a small increase of your activity level can yield big results especially if you earlier led sedentary lifestyles (Fiuza-Luces et al, 2018; Pinckard et al, 2019). One may then ask; how much physical activity is enough for cardiovascular health gain?

It has been established by scientist that engagement in at least 30 minutes of moderate physical exercise per day yields substantial health gains. However, it was equally pointed out that this does not necessarily mean one has to perform the exercise all at once, but that one can exercise throughout the day as long as it add up to 30 minutes. For instance, one could walk a particular distance for 10 minutes in the morning and home again for another 10 minutes, and later in the day undertake stairs climbing or gardening for another 10minutes to make the 30 minutes of exercise for the day.

Cardiovascular Health and Sustainable National Development

The term “health” has been viewed variously by different people. It can be seen as the condition of the body characterized by vigour, vitality and freedom from disease. Health is also seen as the human effectiveness and a qualifying factor for life (Class & Arnett, 2016). This means the healthier we are, the greater potential for effectiveness in whatever we do. However, this paper sees health as the quality of life that renders the individual fit to live most and to serve best. These definitions no doubt leaves one with the understanding that health is indeed a vital factor of man’s life that should be accorded maximum importance for development that can be attained by engagement in routine PA.

Cardiovascular health is the state of the functioning capacity of the heart and blood vessels, to pump and supply blood to the whole body and back to the heart (Fiuza-Luces et al, 2018). This normal function of the heart and blood vessels are sometimes hampered by disease referred to as cardiovascular disease (CVD), which is said to be the number one killer disease in our society today. Cardiovascular disease encompasses a wide range of conditions that affect the heart and vasculature, including arrhythmias, dilated hypertrophic or idiopathic cardiomyopathies, heart failure, atherosclerosis, among others (Fiuza-Luca et al, 2018). They maintained that these conditions can lead to potentially fatal cardiac events such as cerebrovascular disease (CVD), myocardial infarction (heart attack or cardiac arrest etc.). They pointed out that cardiovascular disease maybe congenital, acquired, genetic or environmental in nature, which affects the normal functioning of the circulatory system; adding that shortness of breath, persistent coughing (wheezing), oedema, fatigue, lack of appetite, confusion/impaired thinking, increased heart rate, among others, are notable symptoms of CHD and CVD.

Determining various therapeutic tools to prevent or reduce the incidence of CHD and CVD is vital since the disease pose serious health threats to both male and female genders. It was thus observed that one of the safest and most effective ways to reduce the risk and improve cardiovascular health, overall well-being and quality of life of people is to engage in regular physical activity participation (Arija & Villalobos; Nystoriak & Bhatnagar, 2018; Pinckard et al, 2019).



Physical Activity and Cardiovascular Health for Sustainable National Development

Given the importance of physical exercise in the control of CVD risk factors, the European Society of Cardiology, European Association of Cardiovascular Preventive Medicine have agreed on a common policy statement to encourage integrated action by key stakeholders in order to achieve the broad adoption of a healthy lifestyle pattern of behaviour (including physical activity) on a global scale (Arija & Villalobos, 2017). Scientific evidence supports the concept that PA that is regularly performed has significant beneficial effects on the health of the participants. Scientists therefore contend that active people have lower rate of CHD and CVD than inactive people (Pinckard et al, 2019). For instance, a study showed that bus conductors in London who spent their entire working hours walking the length and breadth of the buses as well as climbing up and down the stairs of the English double-decker buses to collect fares experienced half the coronary heart disease mortality rate compared to their driver counterparts who spent most of their time sitting behind the wheel (Shiroma & Lee, 2010).

Exercise is an important therapeutic remedy for patients who have cardiovascular health problems. For instance, a systematic review of 63 studies found that exercise-based cardiac rehabilitation improved cardiovascular function (Anderson, Thompson, Oldridge, Zwister, Rees, Martin, et al, 2016). They pointed out that these studies consisted of various forms of aerobic exercise at a range of intensities from 50-95% vO_2 , over a period of 1-4 months. They concluded that the overall exercise significantly reduced CVD related mortality disease risk of myocardial infarction, and improved quality of life.

A Separate study found that 4 weeks of high intensity interval training (HIT) in heart failure patients with preserved ejection fraction improved vO_2 peak and induced diastolic dysfunction compared to both pre-training values of the moderate continuous exercise group (Pearson & Smart, 2017). They maintained that studies showed that both moderate and high intensity exercise training improves cardiovascular functions in heart failure patients which are likely related to increase endothelium- dependent vasodilation and improved aerobic capacity.

A recent study provided personalized aerobic exercise rehabilitation program for patient who had acute myocardial infarction for 1 year after a coronary intervention surgery (Zhang, Cao, Jiang & Tang, 2018). They stated that patients who underwent the exercise rehabilitation program had increased ejection fraction (60.81 vs 53 control group), increased exercise tolerance and had reduced cardiovascular risk factors 6 months after starting the exercise rehabilitation program. They stressed that this improvement in cardiovascular health in patients with atherosclerosis or post -myocardial infarction was due to increased myocardial perfusion in response to exercise.

Mechanism Regulating Exercise Induced Benefits on Cardiovascular Health

Scientists believe that several mechanisms mediate the benefits of physical exercise on cardiovascular health. For example, exercise improves cardiovascular health by inducing changes in oxygen delivery, vasculature, peripheral tissues and production of myokines (Pinckard et al, 2019).

Changes in Oxygen Delivery



Exercise improves oxygen delivery throughout the body through promotion of vasodilation and angiogenesis. Vasodilation as an increase in the diameter of blood vessels, while angiogenesis is the physiological process by which new capillary blood vessels are formed from pre-existing one with regular exercise (Borges & Verdoorn, 2017). They explained that improvement of oxygen delivery through vasodilation and angiogenesis protects against ischemic- reperfusion injury in the heart thus preventing heart attack or cardiac arrest.

Exercise Improves Vasculature and Myocardial Perfusion.

Physical exercise induces vascular adaptations to several tissues (Oliver, Ferguson & Laughlin, 2015). They stated that in the heart, the increase in vascularization protects against vascular stress and reduces the likelihood of a cardiac event through increased expression of vascular endothelial nitric oxide synthase (eNOS). It was stressed that exercise increase the intensity of physiological shear stress, inducing the shear stress-dependent activity of C-Src in endothelial cells and increasing expression of eNOS (Pinckard et al, 2019). They pointed out that in the vascular endothelium, eNOS catalyzes the production of nitric oxide (NO) which causes vasodilation, inhibits platelet aggregation and prevents leukocyte adhesion to vessel walls, thus reducing the onset of atherosclerosis, thrombosis, or other cardiac events.

Exercise Improves Mitochondrial Biogenesis and Function

Several of the benefits sustained by exercise are due to mitochondrial adaptations in the body (Lunby & Jacobs, 2016). They explained that exercise improves long-term cardiorespiratory fitness by increasing the mitochondrial content and desaturation of myoglobin in skeletal muscle tissues, improving the oxidative capacity of skeletal muscles. Also that exercise induces adaptations in several cell types and tissues throughout the body as it increases mitochondrial biogenesis growth whereby cells increase mitochondrial mass in skeletal muscles myocyte and cardiomyocytes (Vega et al, 2017).

By increasing the ability of mitochondria to prevent oxidative damage, exercise-induced modifications to mitochondria protects against ischemia-reperfusion damage to the heart (Lundby & Jacob, 2016). They maintained that during ischemia, the absence of oxygen from the heart creates an environment in which the return of oxygenated blood flow leads to the induction of inflammation and oxidative stress rather than restoration of normal function. In contrast exercise-induced adaptations to cardiomyocyte mitochondria dampen oxidative damage caused by ischemia reperfusion, resulting in reduced cardiac injury and decreasing the risk of ischemia- related cardiac dysfunction or death (Kwon, Song, Roltsch & Lee, 2018).

Exercise Enhances Inter-tissue Communication through Release of Myokines.

During exercise, the skeletal muscle acts as a secretory organ by stimulating the production of myokines in the body (Pinckard et al, 2019). They pointed out that myokines are chemical messengers that function in cells to influence cross-talk between different organs including skeletal muscle, heart, liver, etc. They stressed that myokines are of great importance to cardiovascular health because the well-known protective actions of exercise on cardiovascular function are partially mediated by increased secretion of myokines (interleukin-6, follistatin-like 1, myonectin and neuron derived neurotrophic factor). For example that;

Interleukin-6 (IL-6)-inhibits tumor necrosis factor- α (TNF- α) which reduces inflammation and protecting against the formation of atherosclerosis, development of heart failure and subsequent complications including myocardial infarction.



Follistatin-like 1 (Fstl 1)-decreases ischemic injury size through activation of the Akt/AMPK pathway (activating eNOS and revascularization) and early fibroblast which aids in repairs after ischemia reperfusion.

Myonectin (MyoN)-increases fatty acid uptake in adipocyte and hepatocyte and protect against ischemic injury in the heart.

Neuron-Derived Neurotrophic Factor (NDNF) - improves Survival after myocardial infarction by reducing apoptosis (programme cell death) through stimulation of the Akt/Ampk/eNOS pathway thus enhancing revascularization.

Impact of Physical Activity-Induced Benefits on Sustainable National Developments

The term “development” can be seen as a gradual growth of something that would become advanced and stronger (Lemke, 2016). He stresses that development include improvement of the material welfare of the people, eradication of mass poverty, illiteracy, disease, short life expectancy, gender inequality, among others; adding that “sustainable national development” thus means the capacity of a nation to provide her citizenry with basic needs of life that would improve their standard of living over a period of time (Lemke, 2016).

Nigeria as a member of the United Nations Organization (UNO), adopted the Sustainable Development Goal (SDGs) which was born at the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil, in 2012. The General Assembly of the UN adopted the 17 SDGs in September 2015, to be pursued over the next 15 years.

The 2030 Agenda for SDGs according to the Office of the Senior Special Adviser to the President of Nigeria (OSSAPN) on SDGs includes; (1) end poverty everywhere (2) end hunger (3) ensure healthy lives and well-being (4) ensure quality education (5) Achieve gender equality (6) ensure access to water and sanitation (7) ensure access to affordable , reliable and modern energy (8) promote economic growth decent work, (9) Promote resilient infrastructure /industrialized (10) Reduce in equality within and among countries (12) ensure consumption and production pattern (13) combat climate change and its impacts (14) Conserve and use oceans, seas and marine resources (15) Manage forests, combat desertification and reverse land degradation (16)promote just, peaceful and inclusive societies (17) revitalize the global partnership for sustainable development.

With the overarching aspiration of bringing people and the planet together and leaving no one behind, the 2030 Agenda is a unique opportunity to inspire global action for development worldwide including the area of physical activity, particularly through exercise and sports. Nigerians who engage in exercise and sports thus live active lifestyles and are fit would achieve the SDGs as stated by OSSAPN, 2020. Such people would;

- a. Produce enough farm produce for both domestic and commercial use thus helping to eradicate hunger and poverty. The food and agriculture sector offer key solutions for development thus it's central for hunger and poverty eradication. (SDGs: 2 & 1).
- b. Improve health and well-being of the people through reduction of non-communicable disease such as cardiovascular diseases, diabetes, breast and colon cancers, etc (SDG: 3)



- c. Ensure quality education through enhanced readiness for primary, secondary and tertiary education by providing necessary and adequate facilities, equipment and qualified personnel to enhance teaching and learning for improved educational outcomes (SDG: 4).
- d. Achieve gender equality by reducing inequality through empowerment of women and girls for them to have equal access to education, health- care, decent work, representation in political and economic decision making process, etc, (SDG: 5).
- e. Ensure access to good water and sanitation by providing tap or bore-hole water for every house hold and community in both urban and rural areas, and sanitary personnel to dispose refuse in the area to prevent disease outbreak (SDG: 6).
- f. Reduce inequalities by empowering and providing equal opportunities for women and girls through physical activity and sports where they can benefit from the positive impacts that sports has on health and psychosocial conditions (SDG: 10).
- g. Promote safe, sustainable cities and communities through sustainable transport, urbanization and universal access to green spaces. For example, the Table Tennis NePALL Project which aims to promote the inclusion of people with disabilities in sport programmes to foster social development and integration in societies despite significant barriers. Sport created a sense of normalcy and self-efficacy for the survivors of the devastating 2015 earthquake in Nepal (Lemke: 2016 (SDG: 11)).
- h. Protect life on land through sustainable land use by managing forests and planting trees to check desertification thus preventing poverty and hunger (SDG: 15).
- i. Use sports to promote just, peaceful and inclusive societies by providing safe environment at the grassroots and community levels where participants are brought together in pursuit of common goals and interest, learn values of respect, tolerance and fair play and building bridges between communities regardless of their differences (SDG: 16).
- j. Ensure enhancement of global partnership through sport participation by member states of the UN and International Olympic Committee (IOC), for social integration, peace and unity of the world (SDG: 17).

Conclusion

This paper established that vigorous, moderate and even low intensities PA reduce cardiovascular disease risk factors. Exercise was established as important therapeutic remedy for patients with cardiovascular disease, particularly CHD and CVD, thus demonstrating its protective and restorative properties. In patients with CHD and CVD, exercises improve their endothelium-dependent vasodilation, increase their ejection fraction and exercise tolerance, thus improving their quality of life and well-being. Exercise also improves cardiovascular health through increased mitochondrial biogenesis, fatty acid oxidation, dilation of blood vessels leading to myocardial perfusion, and reduction of inflammation, thus protects against development of atherosclerosis, myocardial infarction, etc. Myokines released from skeletal muscle during PA also mediates cardiovascular health benefits through anti-inflammatory action, increased fatty acid oxidation, increased glucose uptake and improved insulin secretion and sensitivity. Participants in PA haven achieved fitness and health thus free from CHD & CVD would able to achieve the SDGs, e.g end poverty everywhere, end hunger, ensure healthy lives and well-being, ensure quality education, achieve gender equality, among others.

Suggestions



1. Individual (male or female) should make regular participation in exercise a habit for optimal health and well-being.
2. The elderly individuals (70 years and above) are to engage in performing low PA such as brisk-walking, gardening, racking, stair-case climbing, to maintain good health.
3. Nigerian scientists and researchers should liaise with the Nigerian Medical Association (NMA), Nigeria Association for Physical, Health Education, Recreation, Sports and Dance (NAPHERSD), and other professional bodies in onerous task of improving the medical and fitness standards of our people, particularly those in high institutions and private sectors.
4. Governments (Federal, States and LGs), to educate the general public on the tremendous benefit of regular PA performance to be gained by participants.

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