EFFECTS OF A RESISTANCE EXERCISE INTERVENTION PROGRAMME ON BODY COMPOSITION, CHRONIC DISEASE RISKS AND STRENGTH SCORES IN PEOPLE LIVING WITH HIV AND AIDS (PLWHA) RECEIVING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

BY

Victor Mbayo

Supervisor: Dr Takshita Sookan (PhD)

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University of KwaZulu-Natal

Westville

Durban, South Africa

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ABSTRACT

Introduction

People living with HIV and AIDS (PLWHA) receiving antiretroviral therapy (ART) increases their life expectancy. Receiving ART coupled with physical inactivity results in increase in prevalence of hyperlipidaemia, obesity and overweight, type 2 diabetes mellitus, lipodystrophy, decrease in mineral bone density and hypertension among others. Resistance exercise (RE) interventions address chronic disease risks affecting PLWHA receiving ART.

Aim

The study investigated the effect of RE on body composition, chronic disease risks and strength scores in PLWHA receiving ART.

Methods

The study followed an experimental, pre-and-post-test design. The sample constituted 128 PLWHA, of black African ethnic groups, aged between 18-45 years and receiving ART. The participants were recruited from Glenview and Mabvuku suburbs in Harare. The participants from Glenview were randomly allocated to an experimental group i.e. the EXP group (n=64) performing REs three days per week and those from Mabvuku to a control group i.e. the CON group (n=64) for 12 weeks following a pre-test session. Body composition (waist-to-hip ratio, body mass index, percentage body fat, fat mass, lean body mass), chronic disease risks (fasting blood glucose, fasting total blood cholesterol, blood pressure) and strength (1RM tests) scores were pre-and-post-test measured in all participants observing standard protocols. Chi-square, Fisher’s test, linear regression, Binomial test, Spearman’s and Pearson’s correlations were conducted. SPSS statistical package version 22 was used and significance set at $p<0.05$.

Results

Post-test body composition scores remained high in the CON group (n=64), but improved significantly (p<.0005) in the EXP group (n=64). Significant differences (p<.0005) were noted in post-test chronic disease risks between the EXP group (n=64) and the CON group (n=64). Post-test fasting blood glucose and fasting total blood cholesterol scores in the CON group (n=64) were significantly higher (p<.0005) than in the EXP group (n=64). A 100% of the CON group (n=64) participants remained with pre-hypertension at post-test, while 66% of the EXP group (n=64) with hypertension 2 improved to hypertension 1.

Strength scores in the EXP group (n=64) participants significantly increased (p<.0005) for bench press, squat, bicep curl and leg curls than in the CON group (n=64). There were no effects of gender in respect of fasting blood glucose and total fasting blood cholesterol scores in both groups at post-test.

Conclusion

The results showed that the 12 week RE intervention programme improved body composition, chronic disease risk and strength scores in PLWHA receiving ART. Resistance exercise is safe and beneficial for PLWHA in resource-constrained settings. Policy makers may utilise this information to include RE programmes for PLWHA as a healthy lifestyle intervention in Zimbabwe.

Keywords

HIV, ART, Chronic disease risks, Resistance exercise, Body composition, Strength

DECLARATION

I, Victor Mbayo, declare that

(i) The research reported in this thesis, except where otherwise indicated is my original research.

(ii) This thesis has not been submitted for any degree or examination at any other university.

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Signed: 

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LIST OF ABBREVIATIONS

1RM	One Repetition Maximum
ACSM	American College of Sports Medicine
AHA	American Heart Association
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
BC	Body Composition
BCM	Body Cell Mass
BF	Body Fat
BFR	Body Fat Redistribution
BMD	Bone Mineral Density
BMI	Body Mass Index
BP	Blood Pressure
BREC	Biomedical Research Ethics Committee
CAD	Coronary Artery Disease
CET	Cardiorespiratory Exercise Training
CHS	College of Health Sciences
CON	Control
CV	Cardiovascular
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
DCER	Dynamic Constant External Resistance
DM	Diabetes Mellitus
DOMS	Delayed Onset Muscle Soreness
DSP	Distal Symmetrical Poly-neuropathy
EBP	Elevated Blood Pressure
EXS	Exercises Group
FBG	Fasting Blood Glucose
FFM	Fat Free Mass
FM	Fat Mass
GoZ	Government of Zimbabwe
HBP	High Blood Pressure
HDL	High Density Lipoprotein

HDL-C	High Density Lipoprotein Cholesterol
HIV	Human Immunodeficiency Virus
HR-QOL	Health Related Quality of Life
IGT	Impaired Glucose Tolerance
IGI	Impaired Glucose Intolerance
IPAR-Q	International Physical Activity Readiness Questionnaire
ISAK	International Society for the Advancement of Kinanthropometry
Kg	Kilogram
LBM	Lean Body Mass
LBP	Low Blood Pressure
LDL	Low Density Lipoprotein
LDL-C	Low Density Lipoprotein Cholesterol
LPS	Lipopolysaccharide
Max HR	Maximum Heart Rate
MI	Myocardial Infarction
mmHg	Millimetres of Mercury
mmol/L	Millimoles per litre
MoHCC	Ministry of Health and Child Care
MRCZ	Medical Research Council of Zimbabwe
MS	Metabolic Syndrome
NAC	National AIDS Council
NCDs	Non-Communicable Diseases
OI	Opportunistic Infection
PAD	Peripheral Artery Disease
PIO	Pioglitazone
PI	Protease Inhibitors
PMTCT	Prevention of Mother to Child Transmission
PRE	Progressive Resistance Exercise
QOL	Quality of Life
RE	Resistance Exercise
REAC	Resistance Exercise and Aerobic Conditioning
RPE	Rated Perceived Exertion
SBP	Systolic Blood Pressure
SSA	Sub-Saharan Africa

TBF	Total Body Fat
TBC	Total Blood Cholesterol
FTBC	Fasting Total Blood Cholesterol
TBF	Total Body Fat
TBW	Total Body Weight
TC	Total Cholesterol
UKZN	University of KwaZulu-Natal
UN	United Nations
UNICEF	United Nations Children's Education fund
VO_2 max	Maximum Oxygen Consumption
WHR	Waist-to-hip ratio
WC	Waist Circumference
WHO	World Health Organisation
ZNNP+	Zimbabwe National Network for People Living with HIV/AIDS

CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND

The American College of Sports Medicine (ACSM) validate resistance exercise (RE) as an important health benefit for people living with HIV/AIDS (PLWHA), in mitigating chronic disease risks and improving strength scores (ACSM, 2014 p294; Souza et al., 2011; Yarasheski et al., 2001). The identifiable chronic disease risk factors in PLWHA are modifiable through lifestyle changes, (Compston, 2015; Junior et al., 2010; McComsey et al., 2010; Stanley and Grinspoon, 2012). Studies show that PLWHA can safely perform REs without aggravating their clinical status (Quiles and Ortiz, 2017). Exercise training reduces chronic disease risks in PLWHA by improving body composition patterns (Malita et al., 2005).

The benefits of exclusive RE seem as if they vary from those of other exercise modalities. However it is important to note that RE alone increases lean body mass, muscle strength, sum of skinfolds, limb girths and mitigate muscle wasting more than quality of life in PLWHA (Leach et al., 2015, Grace, 2016, Neto et al., 2013). Although RE are not widely used they are safe and an effective non-pharmacological therapy for PLWHA (Grace et al., 2016, Gomes-Neto et al., 2015, Lopez, 2015).

Furthermore, RE improves glucose tolerance, percentage body fat, psychological status, insulin sensitivity and lipid profiles in PLWHA (Grace et al., 2016). The REs performed are many and include resistance bands, dumb bell free weights, body weights, cables, machines, kettle bells, medicine balls and plyometrics among others (Grace et al., 2016, Sandler, 2010, p.22). Therefore when conducting RE for PLWHA they have to be conducted under supervision. It has been shown that RE improve bone mineral density and essentially reduce body weight in PLWHA (Neto et al., 2013). The lean body mass improves more in PLWHA especially males experiencing wasting in relation to notable improvements in day to day bodily functioning (Quiles and Ortiz, 2017). In PLWHA such as women, RE have an equally beneficial effect for it also improves muscles strength and lean muscle mass (Quiles and Ortiz, 2017). When the RE is progressively prescribed women can experience reductions in fat mass while muscle mass and quality of life scores improve (Quiles and Ortiz, 2017). Importantly RE can effectively improve blood lipids, glucose (chronic disease risks) and bone metabolism in PLWHA (Quiles and Ortiz, 2017 and O’Brien et al., 2017). However, exclusive RE researches are few although presenting evident benefits for PLWHA.

1.2. AIM OF THE STUDY

The aim of the study was to investigate the effect of a resistance exercise intervention programme on body composition, chronic disease risks and strength of PLWHA receiving ART in Zimbabwe.

1.3. OBJECTIVES

1.3.1. To investigate body composition scores post 12 week RE exercise intervention programme.

1.3.2. To investigate chronic disease risk factors in PLWHA at pre and post test.

1.3.3. To investigate the strength levels at pre and post test.

1.4. HYPOTHESIS

1.4.1. There is a relationship between increased weight, fat mass, lean body mass and 12-week RE intervention programme.

1.4.2. A 12-week RE intervention programme improves strength scores in PLWHA receiving ART.

1.4.3. A 12-week RE intervention programme reduces the risk of chronic disease in PLWHA.

1.5. DELIMITATIONS OF THE STUDY

The study only included participants without opportunistic infections, not participating in a pre-existing exercise programme. The pre-menopausal female subjects were none pregnant or lactating, or had had regular menstrual cycles for the past year. Only those medically diagnosed were recruited in this study. The study was delimited by excluding individuals with Acquired Immune Deficiency Syndrome; musculoskeletal disorders; seriously ill and bed-ridden. HIV-negative individuals or those with any history of leg injury, back pain; congestive heart failure; angina, cardiovascular and peripheral vascular diseases were excluded. Individuals who had experienced a cold or fever at least one month leading up to the protocol or with flu symptoms and of non-black African ethnicity did not participate in this study. Further, individuals receiving medications affecting central or peripheral circulation, on nonsteroidal anti-inflammatory agents or serotonin reuptake inhibitors and with any other health circumstances that could be exacerbated by lifting weights were left out.

1.6. SIGNIFICANCE OF THE STUDY

Zimbabwe has limited data on the effect of REs for PLWHA receiving ART. In undertaking this study, it is perceived that it may lead to further investigation on the effects of REs as an intervention to improve health and lifestyles of PLWHA receiving ART in Zimbabwe. The study is important in forming the basis for coming up with exercise programmes for HIV patients in Zimbabwe. This is perceived to contribute towards encouraging PLWHA to live healthier while ageing with the disease by engaging in REs. The study is wholly believed to add to the body of knowledge in the care and support for PLWHA in the country.

1.7. DEFINITION OF TERMS

a) Atherosclerosis.

Refers to a disease in which plaque builds up inside the arteries.

b) Cholesterol.

Is a type of fat in the blood carried by a type of protein known as lipoprotein.

c) Chronic disease.

Also known as non-communicable disease that emerges after long exposure to an unhealthy lifestyle physical inactivity, tobacco use, consuming high fat diets, sugars, salts).

d) Comorbidity.

Is the presence of one or more additional diseases or condition together with a primary disorder or disease.

e) Dyslipidaemia.

Is an elevated total or low-density lipoprotein cholesterol levels or low levels of high-density lipoprotein.

f) Glucose tolerance.

Is a pre-diabetic state of hyperglycaemia associated with insulin resistance.

g) Health-related quality of life.

Is a multidimensional concept that includes domains related to physical, mental, emotional and social functioning.

h) Hyperglycaemia.

Is an excess of glucose in the blood stream often associated with diabetes mellitus.

i) **Hyperlipidemia.**

Are elevated lipid fat levels in the blood.

j) **Hypertension.**

Is an abnormal state of high blood pressure.

k) **Intervention.**

Is an action to improve a medical disorder or act of intervening.

l) **Lipodystrophy.**

Is a disorder of the adipose tissue characterized by selective loss of body fat.

m) **Maximum oxygen consumption.**

Is the amount of oxygen the body can use during a specific period of intense exercise dependent on body weight and strength of lungs.

n) **Multi-morbidity.**

Is the presence of two or more chronic medical conditions in an individual.

o) **One repetition maximum (1RM).**

Is the greatest weight an individual can lift with one repetition or contraction.

p) **Osteoporosis.**

Is a medical condition in which the bones become brittle and fragile from loss of tissue.

q) **Poly-neuropathy.**

A general degeneration of peripheral nerves that spread towards the centre of the body.

r) **Progressive resistance exercise.**

Is a method of strength training that involves the utilisation of resistance observing the principle of overload.

s) **Protease inhibitors.**

Is a class of antivirus drugs that’s that are widely used to treat HIV/AIDS and hepatitis.

t) **Resistance exercise.**

Are exercises that require muscle contraction against a force or weight.

u) **Resistance exercise.**

Is any of the exercises that forces the skeletal muscles to contract.

v) **Sarcopenia.**

The loss of skeletal muscle mass and strength.

w) **Triglycerides.**

Are the main constituents of natural fats and oils.

The outline of this thesis is as follows:

Chapter Two provides a review of related literature regarding body composition and chronic disease risk responses of RE interventions in PLWHA.

Chapter Three: Article 1 is a systematic review study intended for submission to a journal for publication.

Chapter Four: Article 2 is the original research manuscript to be submitted to a journal for publication (in the accepted format for submission of a Masters dissertation at the University of Kwa-Zulu Natal) and;

Chapter Five provides the conclusions of the study and recommendations for future research.

CHAPTER TWO: REVIEW OF LITERATURE

2.1. INTRODUCTION

The Human Immunodeficiency Virus (HIV) has become a persistent health challenge and many families are left either infected or affected (WHO, 2016). The concerns are that HIV still has no cure, in spite of ongoing efforts (Lederman at al., 2016). The preferred treatment available to people living with HIV/AIDS (PLWHA) is antiretroviral therapy (ART) (AIDSinfo, 2016).

Antiretroviral therapy increases life expectancy of PLWHA (WHO, 2016). However, the incidence of chronic disease in PLWHA is also increasing (Guaraldi et al., 2015). To a greater extent studies provide relevant information on the valuable effects of exercises in lessening the effects of chronic disease risks in PLWHA (Roubenoff and Wilson, 2001; Srikanthan and Karlamangla, 2014). Resistance exercise (RE) offer the possibility of averting the chronic disease risks in PLWHA (Mkandla et al., 2016; Phillips et al., 2006; Souza et al., 2011; Hamid and Rajah, 2015; Yarasheski et al., 2001).

2.2. SIDE EFFECTS OF ART AND THE ROLE OF EXERCISE IN PLWHA

Antiretroviral therapy is not a cure for HIV, but it should be taken conscientiously for life to preserve immune function (Ministry of Health and Child Welfare, 2013). The chronic disease risks affecting PLWHA are classified as early onset, late onset and unintended (Lundgren and Mocroft, 2006). The effects of ART in PLWHA are evident through alteration in body fat, mineral bone density, blood glucose, blood pressure and body composition leading to increased incidences of chronic disease risks.

2.2.1. SIDE EFFECTS OF ART ON TOTAL CHOLESTROL AND THE ROLE OF EXERCISE IN PLWHA

Fasting total blood cholesterol and triglyceride levels are used to identify individuals at risk of chronic diseases. The optimal targets for fasting blood cholesterol are 4.1mmol/L or 160mg/dL; and 5.1mmol/L or 200mg/dL for those at high-risk (ACSM, 2014, p. 46).When considering total serum cholesterol, a value of <5.1mmol/L or <200mg/dL is desirable, while borderline high ranges from 5.1 to 6.1mmol/L or 200 to 239mg/dL; and anything >6.21mmol/L or >240mg/dL is very high (ACSM, 2014, p 46).

Hyperlipidaemia (high level of blood lipids) and fat redistribution (lipodystrophy), are caused by Zidovudine, Norvir, Sustiva and Stavudine ART drugs, and are the most common chronic disease risks in PLWHA (AIDSinfo, 2016; Teklay et al., 2013). Didanosine, an ART drug also causes fat redistribution (Hubbard, 2007). In India, high mean total blood cholesterol levels were evident among HIV-infected males following a shorter period on ART (Zephy, Lakshmi and Ashraff, 2015). Zidovudine, Lamivudine and Nevirapine (first line of treatment) were the ART drugs the PLWHA were receiving (Zephy et al., 2015).

Fat accumulation in PLWHA receiving ART are associated with mitochondrial toxicity occurring following combinations of thymidine-containing nucleoside reverse transcriptase inhibitors, plus a protease inhibitor (PI) (Hubbard, 2007; Neto et al., 2013). In Brazil, studies show that dyslipidaemia and triglycerides with levels >150 mg/dl were evident among PLWHA, after only three years of receiving ART (Neto et al., 2013). Dyslipidaemia (abnormally elevated cholesterol or blood lipids) was closely associated with lopinavir use although more participants in their study were receiving lamivudine–zidovudine (Neto et al., 2013).

In Zimbabwe, some study found that major adverse drug reactions in PLWHA were peripheral neuropathy and lipodystrophy (Nemaura et al., 2013). In Spain, chronic disease risk prevalence was high and gradually increased with age among PLWHA (Jerico et al., 2005). Many patients taking Stavudine (d4T) and lopinavir/ritonavir presented with chronic disease risks, adjusted for age and body mass index (Jerico et al., 2005). The same findings were evident in a Cameroonian study involving patients receiving ART for more than 3.5 years (Nsagha et al., 2015). The results were independently related to total blood cholesterol scores ≥ 200 mg/dl or raised low density lipoprotein-cholesterol values (Nsagha et al., 2015). This shows that PLWHA receiving PI drugs may have alterations in their body fats (Malapati et al., 2014).

Although statins are a more effective treatment for increased blood cholesterol levels, there is need to raise awareness on its risks (ACSM, 2014, p.295). This shows that lifestyle modifications involving RE regimens may also be adopted in managing dyslipidaemia among PLWHA without the need for more medications to address the risk (ACSM, 2014, p.286). The benefit of REs in addressing dyslipidaemia in PLWHA is discussed in subsequent sections.

2.2.2. SIDE EFFECTS OF ART ON BONE MINERAL DENSITY AND THE ROLE OF EXERCISE ON PLWHA

Tenofovir Alafenamide is a novel drug of the antiviral acyclic nucleoside phosphonate tenofovir type, which has enhanced properties compared to tenofovir disoproxil fumarate (Ray et al., 2016). The generally well-tolerated, potent tenofovir disoproxil fumarate therapy causes reductions in bone mineral density in PLWHA (Grund et al., 2009; Ray et al., 2016). A decreased bone mineral density is a chronic disease risk that increases the incidence of osteopenia in PLWHA (Ray et al., 2016). Bone mineral density losses may reach 2 to 6% in the hip and backbone during the first 2 years of ART (Compston, 2015; Stein et al., 2008).

The stimulation of osteoclast creation and inhibition of osteoblast function by some PI, zidovudine and reverse-transcriptase inhibitor causes a reduction in bone mineral density (Womack et al., 2011). A reduction in bone mineral density cause increased fracture risks in PLWHA (Battalora, Young and Overton, 2014; Yin et al., 2012). The condition can progress to bone demineralisation in individuals following an average of two and half years receiving ART (Bonjoch et al., 2010). The associated factors include age, sex, low body mass index and time on PI or tenofovir current use of PI (Bonjoch et al., 2010; Compston, 2015; Ray et al., 2016; Womack et al., 2011).

There is limited information on the reduction in bone mineral density in black African PLWHA (Compston, 2015). However, one study conducted in Nigeria noted a significant prevalence of osteopenia (47%) and osteoporosis (32%) among PLWHA (Alonge et al., 2013). Authors have shown that exercises reduce the risk of osteoporotic fractures, enhance bone mass and reduce rate of bone mineral loss (ACSM, 2014, p.316). Resistance exercise increase muscle and bone strength which limits the risks of falling while improving balance (ACSM, 2014, p.316). Furthermore, if PLWHA undertake RE programmes they directly slow down bone mineral density loses in the backbone and hip (ACSM, 2014, p.316).

2.2.3. THE SIDE EFFECTS OF ART ON FASTING BLOOD GLUCOSE AND THE ROLE OF EXERCISE IN PLWHA

Monitoring of fasting blood glucose provides a risk indicator of cardiovascular disease progression in clinical and general populations (ACSM, 2014, p.278). The desired fasting blood glucose scores are <110mg/dL or <6.1mmol/L (ACSM, 2010, p.279). The diagnostic criteria for normal fasting blood glucose levels are shown in the table below:

Table i: Plasma blood glucose classification criteria

Normal	**Prediabetes**	**Diabetes Mellitus**
Fasting blood glucose <100mg/dL or 5.55mmol/L	Impaired Fasting glucose 100-125mg/dL or 5.55 to 6.94mmol/L	Symptomatic with causal glucose ≥200mg/dL or 11.10mmol/L
	Impaired glucose tolerance 140-199mg/dL or 7.77-11.04mmol/L during an oral glucose tolerance test (OGTT)	Fasting plasma glucose ≥126-200mg/dL or 6.99-11.10mmol/L during OGTT.

Source: Adapted from (ACSM, 2014, p.279)

The incidence of insulin resistance, impaired glucose tolerance and type 2 diabetes in PLWHA receiving ART has increased (Wiwanitkit, 2007). There are more PLWHA frequently diagnosed with high fasting blood glucose scores following commencement of ART (Wiwanitkit, 2007). Type 2 diabetes was observed in PLWHA receiving ART for three years with smoking further aggravating the condition (Neto et al., 2013). In Nigeria, PLWHA receiving Lamivudine, Nevirapine, Combivir, Combipack and Efavirenz (first-line ART drugs) recorded a 6% prevalence of type 2 diabetes (Chukwuanukwu et al., 2013). In the same study, those receiving truvada (comprising tenofovir and emtricitabine) and Aluvida (a PI comprising lopinavir and ritonavir) (second-line ART drugs) recorded a 10% prevalence of impaired glucose tolerance after three months of receiving the drugs (Chukwuanukwu et al., 2013). None of the participants had a history of diabetes in their families, or diabetes risk factors (Chukwuanukwu et al., 2013).

In Rwanda, Dusingize et al. (2013) found that HIV-infected females 42-43years had minimal differences in fasting blood glucose scores in relation to the none HIV-infected. However, the HIV-negative women had higher, fasting glucose scores (Dusingize et al., 2013). Antiretroviral drug ritonavir (Norvir), received in combination with another PI, increases the risk of diabetes or hyperglycaemia (Stein et al., 2008). Increased age in both males and females receiving ART increases the chances of developing type 2 diabetes (Domo and Jalyson, 2015; Stein et al., 2008).

The literature stresses that ART causes high fasting blood glucose scores in PLWHA (Wiwanitkit, 2007; Chukwuanukwu et al., 2013;Dusingize et al., 2013; Domo and Jalyson, 2015; Stein et al., 2008). Those with type 2 diabetes or pre-diabetes require glycaemic control through diet and exercise among other lifestyle management methods (ACSM, 2014, p.290). Importantly REs have been shown to improve the body's ability to utilise blood sugar, reducing the incidence of type 2 diabetes (ACSM, 2014, p.291).

2.2.4. SIDE EFFECTS OF ART ON BLOOD PRESSURE AND THE ROLE OF EXERCISE IN PLWHA

High blood pressure scores are related to the risk of cardiovascular events (ACSM, 2014, p.299). The following table shows the new classification of blood pressure, each with corresponding expectations on lifestyle modifications according to American College of Cardiology (ACC) and American Heart Association (AHA).

Table ii: The new blood pressure classification according to ACC and AHA

BP Category	Systolic BP	Diastolic BP	Treatment or Follow-up
Normal	<120 mm Hg	<80 mm Hg	• Evaluate yearly; encourage healthy lifestyle changes to maintain normal BP
Elevated	120-129 mm Hg	<80 mm Hg	• Recommend healthy lifestyle changes and reassess in 3-6 months
Hypertension : Stage 1	130-139 mm Hg	80-89 mm Hg	• Assess the 10-year risk for heart disease and stroke using the atherosclerotic cardiovascular disease (ASCVD) risk calculator • If risk is less than 10%, start with healthy lifestyle recommendations and reassess in 3-6 months • If risk is greater than 10% or the patient has known clinical cardiovascular disease (CVD), diabetes mellitus, or chronic kidney disease, recommend lifestyle changes and BP-lowering medication (1 medication); reassess in 1 month for effectiveness of medication therapy If goal is met after 1 month, reassess in 3-6 months • If goal is not met after 1 month, consider different medication or titration • Continue monthly follow-up until control is achieved
Hypertension : Stage 2	≥140 mm Hg	≥90 mm Hg	• Recommend healthy lifestyle changes and BP-lowering medication (2 medications of different classes); reassess in 1 month for effectiveness • If goal is met after 1 month, reassess in 3-6 months • If goal is not met after 1 month, consider different medications or titration • Continue monthly follow-up until control is achieved

Source: Adapted from (ACC/AHA, 2017)

It has been shown that age, male gender and family history are associated with hypertension (Junior et al, 2010). Furthermore, a body mass index > 25kg/m^2, a large waist circumference, fasting total blood cholesterol >200mg/dl, with >100 mg/dl blood glucose levels, >150mg/dl triglyceride, duration on ART and CD4 count >200 cells/mm^3 in PLWHA are associated with hypertension (Crane et al., 2006; Junior et al., 2010; Palacios et al., 2006). Blood pressure can increase in PLWHA within 48 weeks of initiating ART and it is important to consider early detection of hypertension for healthy lifestyles management purpose (Palacios et al., 2006). Another study observed that there was an increase in the incidence of high blood pressure and new diagnoses of hypertension in PLWHA receiving ART over a 10-year period (Crane et al., 2006). Participants receiving lopinavir/ritonavir had the highest risks of developing high blood pressure compared to efavirenz-based regimens (Crane et al., 2006).

However, in Western Kenya, it was shown that more mortality rates were noticed in PLWHA with low blood pressure over a five year period (Bloomfield et al., 2014). There were increased mortality rates among the males with low systolic blood pressure, than those with normal systolic blood pressure (Bloomfield et al., 2014). The study did not mention type of ART drugs the PLWHA were receiving. Very low CD4 cell counts and prolonged periods on ART are associated with chronic hypertension; while delaying the start of ART until a state of advanced immunosuppression is reached might add or fuel those chronic disease risks associated with receiving ART (Manner et al., 2013). The prolonged use of ART was shown to be significantly associated with a higher prevalence of systolic hypertension (Seaberg et al., 2005). Studies in Zimbabwe, have also noticed the prevalence of hypertension in PLWHA receiving ART in a predominantly rural setting (Mutede et al., 2015). Receiving ART for ≥ two years, >0.85 for waist-to-hip ratio in women, body mass index >25kg/m^2, smoking, sedentary recreation and high salt intake increased hypertension incidences (Mutede et al., 2015).

The literature shows that receiving ART causes hypertension in PLWHA though a general consensus on causative ART drugs was not clearly established (Junior et al., 2010; Crane et al., 2006; Palacios et al., 2006; Bloomfield et al., 2014; Manner et al., 2013; Seaberg et al., 2005; Mutede et al., 2015). Individuals with 120-139 mmHg and 80-89 mmHg for systolic and diastolic blood pressure respectively are strongly advised to adopt healthy lifestyle changes including weight reduction, exercise and a healthy diet (ACSM, 2014, p.296). Aerobic exercises are highly recommended, however, they have to be complemented by moderate- intensity RE (ACSM, 2014, p.297). This shows that RE are important interventions in addressing changes in blood pressure scores among PLWHA receiving ART.

2.2.5. SIDE EFFECTS OF ART ON BODY COMPOSITION AND THE ROLE OF EXERCISE

The body mass index, also known as the Quetelet index, is the most frequently used standard to define excess body weight in clinical and non-clinical populations.

$$\text{The body mass index equation is: } \frac{\text{Weight (kg)}}{\text{Height}^2\text{ (m)}}$$

Table iii: Body mass index classification according to World Health Organisation

Classification	BMI (kg/m²)	Sub-classification		BMI (kg/m²)
Underweight	< 18.50	Severe thinness		< 16.00
		Moderate thinness		16.00 - 16.99
		Mild thinness		17.00 - 18.49
Normal range	18.5 - 24.99	Normal		18.5 - 24.99
Overweight	≥ 25.00	pre-obese		25.00 - 29.99
		Obese	obese class I	30.00 - 34.99
		(≥ 30.00)	obese class II	35.00 - 39.99
			obese class II	≥ 40.00

Source: Adapted from (World Health Organisation, 2016)

When body mass index scores increase beyond 25 kg/m^2 health problems begin to increase (WHO, 2016). Body mass index score ≥30.00 kg/m^2 increases the incidence of hypertension, cancer, type 2 diabetes mellitus and dyslipidaemia (ACSM, 2014, p.318). Waist-to-hip-ratio has been proven to assess body fat distribution and determining the risk of chronic diseases (ACSM, 2014, p.66). It is calculated by measuring the circumference of the waist just above the iliac crest and dividing this value by the circumference of the hips (a horizontal extent taken at the greatest boundary of the buttocks). The table below shows wait-to-hip classifications;

Table iv Waist-hip-ratio classification according to World Health Organisation

Gender	Acceptable			Unacceptable	
	Excellent	Good	Average	High	Extreme
Male	< 0.85	0.85 - 0.90	0.90 - 0.95	0.95 - 1.00	> 1.00
Female	< 0.75	0.75 - 0.80	0.80 - 0.85	0.85 - 0.90	> 0.90

Source: Adapted from (World Health Organisation, 2016)

Skinfold measurements are an ideal field procedure to determine body composition levels, since the amount of subcutaneous fat is proportional to the volume of body fat (ACSM, 2014, p.67). The skinfold sites range from 3 to 8, for which equations have been developed to predict body density and percentage body fat scores based on age, sex, race, and population type (ACSM, 2014, p.69). The following tables show fitness categories in relation to percentage body fat classifications in men and women.

Table v: Fitness categories for percentage body fat of men by age

		Age (year)					
%		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**	**70–79**
99	Very lean[a]	4.2	7.3	9.5	11.0	11.9	13.6
95		6.4	10.3	12.9	14.8	16.2	15.5
90	Excellent	7.9	12.4	15.0	17.0	18.1	17.5
85		9.1	13.7	16.4	18.3	19.2	19.0
80		10.5	14.9	17.5	19.4	20.2	20.1
75	Good	11.5	15.9	18.5	20.2	21.0	21.0
70		12.6	16.8	19.3	21.0	21.7	21.6
65		13.8	17.7	20.1	21.7	22.4	22.3
60		14.8	18.4	20.8	22.3	23.0	22.9
55	Fair	15.8	19.2	21.4	23.0	23.6	23.7
50		16.6	20.0	22.1	23.6	24.2	24.1
45		17.5	20.7	22.8	24.2	24.9	24.7
40		18.6	21.6	23.5	24.9	25.6	25.3
35	Poor	19.7	22.4	24.2	25.6	26.4	25.8
30		20.7	23.2	24.9	26.3	27.0	26.5
25		22.0	24.1	25.7	27.1	27.9	27.1
20		23.3	25.1	26.6	28.1	28.8	28.4
15	Very poor	24.9	26.4	27.8	29.2	29.8	29.4
10		26.6	27.8	29.2	30.6	31.2	30.7
5		29.2	30.2	31.3	32.7	33.3	32.9
1		33.4	34.4	35.2	36.4	36.8	37.2
***n* =**		1,844	10,099	15,073	9,255	2,851	522

Total *n* = 39,644

Adapted from (ACSM, 2014, p.73)

Table vi: Fitness categories for percentage body fat of women by age

%		Age (year) 20–29	30–39	40–49	50–59	60–69	70–79
99	Very lean[a]	11.4	11.2	12.1	13.9	13.9	11.7
95		14.0	13.9	15.2	16.9	17.7	16.4
90	Excellent	15.1	15.5	16.8	19.1	20.2	18.3
85		16.1	16.5	18.3	20.8	22.0	21.2
80		16.8	17.5	19.5	22.3	23.3	22.5
75	Good	17.6	18.3	20.6	23.6	24.6	23.7
70		18.4	19.2	21.7	24.8	25.7	24.8
65		19.0	20.1	22.7	25.8	26.7	25.7
60		19.8	21.0	23.7	26.7	27.5	26.6
55	Fair	20.6	22.0	24.6	27.6	28.3	27.6
50		21.5	22.8	25.5	28.4	29.2	28.2
45		22.2	23.7	26.4	29.3	30.1	28.9
40		23.4	24.8	27.5	30.1	30.8	30.5
35	Poor	24.2	25.8	28.4	30.8	31.5	31.0
30		25.5	26.9	29.5	31.8	32.6	31.9
25		26.7	28.1	30.7	32.9	33.3	32.9
20		28.2	29.6	31.9	33.9	34.4	34.0
15	Very poor	30.5	31.5	33.4	35.0	35.6	35.3
10		33.5	33.6	35.1	36.1	36.6	36.4
5		36.6	36.2	37.1	37.6	38.2	38.1
1		38.6	39.0	39.1	39.8	40.3	40.2
n =		1,250	4,130	5,902	4,118	1,450	295

Total *n* = 17,145

Adapted from (ACSM, 2014, p.74)

Body mass index, skinfold measurements and waist-hip-ratio offer a valuable indication of general health and risk stratification during assessments of clinical and healthy populations (ACSM, 2014, p.67). Underweight remains an important condition in PLWHA receiving ART but those newly diagnosed with HIV-infection can experience weight gain even though some experience no change (Denue et al., 2013). The PLWHA can become overweight and obese due to ART (Denue et al., 2013).

In a salient report, it has been shown that the prevalence of central obesity is associated with greater consumption of lipids, although carbohydrates ingested had a negative correlation with central obesity (Jaime et al., 2006). Increases in body mass index can be associated with minor increases in CD4 cell counts (Jones et al., 2003). About 40-50% of PLWHA exhibit an abnormality in body composition when they start to receive ART (Grinspoon and Carr, 2005). The major factors associated with overweight and obesity include: being female, older age, receiving ART for five years, living an over-indulgent lifestyle, hypertension, and WHO HIV stage 2 (Guehi et al., 2016).

Erlandson et al. (2016) however, in a fifteen year observational study, compared body composition between HIV-infected and uninfected individuals. They found out that body mass index gains were slower among PLWHA with 40 years or less and plateaued after the age of 60 in both groups (Erlandson et al., 2016). Furthermore, ethnic Blacks and Hispanics appeared were associated more with greater body mass indexes (Erlandson et al., 2016).

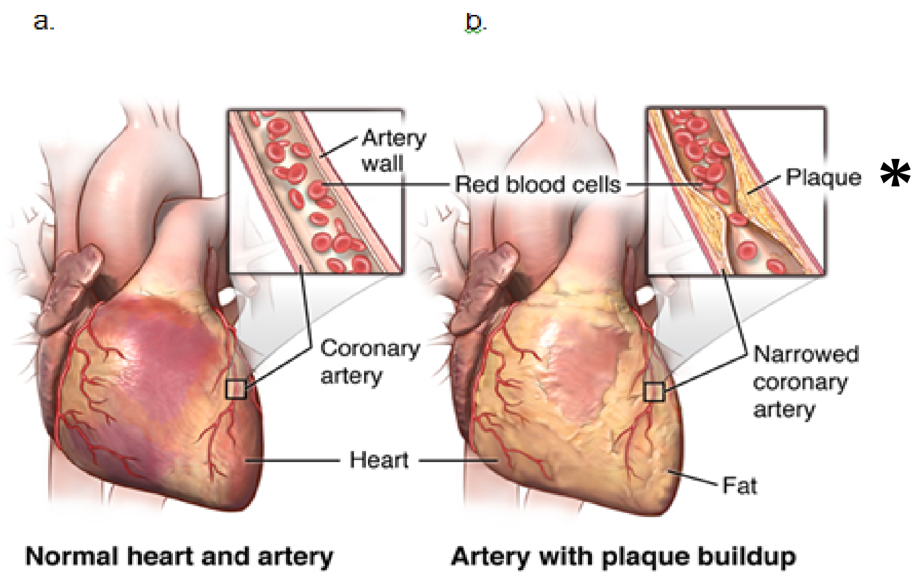
Sharma et al. (2014) showed that after receiving ART medication, 40% of women became overweight, 47% obese and 71% of overweight women stayed obese while 27% became unhealthily heavy. Each year of reverse-transcriptase inhibitor use reduced the chances of reaching a higher body mass index score by 3%; while each year of PI or non-nucleoside reverse transcriptase inhibitors use increased by 6% the chance of reaching a higher body mass index score (Sharma et al., 2014).

In a study group of women on ART in Sub-Saharan Africa (SSA), increases in the prevalence of obesity were observed over a ten year period (McCormick et al., 2014). However, in contrast to another study it showed that a longer duration on ART may not be a predictor of obesity (Denue et al.,2013). Studies in Zimbabwe, revealed the prevalence of under-nutrition and over-nutrition (overweight and obesity) among PLWHA enrolled in ART clinics and the factors were associated with increased ill health and mortality (Takarinda et al., 2017). It was found out that females, aged ≥45years, wealthier and with CD4 counts >350 cells/mL were more likely to be overweight or obese (Takarinda et al., 2017). The researchers referred to this trend as reflecting a change in the pattern of HIV infection to a chronic manageable condition (Takarinda et al., 2017).

In summary, it appears that increased body composition scores increases the risk of chronic diseases in PLWHA (Cade et al., 2013; Singh et al., 2013). It is important to note that there remain concerns about the effects of newer ARTs on chronic disease risks in PLWHA (Srinivasa and Grinspoon, 2014). Overweight and obese PLWHA are encouraged to take part in consistent physical activity, exercise and weight loss management programmes (ACSM, 2014, p.298). It was shown that there are few well-designed studies involving supervised exercises to prevent weight regain in PLWHA and therefore RE are safely recommended in addressing the condition (ACSM, 2014, p.298).

2.2.6. CHRONIC DISEASES AND THE ROLE OF EXERCISE IN PLWHA

Antiretroviral therapy has clinically transformed the lives of PLWHA, reducing their morbidity and mortality rates (Werberich et al., 2013). It is a concern that higher rates of chronic disease have been noted in PLWHA (Friis-Møller et al., 2007). Grochocinski (2011) asserted that there are increased incidences of myocardial infarction (heart attack) with cumulative year on year use of PI in PLWHA. The consumption of high fat diets by PLWHA has been shown to increase the chances of blocking arterial walls causing a reduction in the amount of blood supply and oxygen to the heart (Grochocinski, 2011). The figure below therefore shows a healthy heart artery compared to a blocked artery.

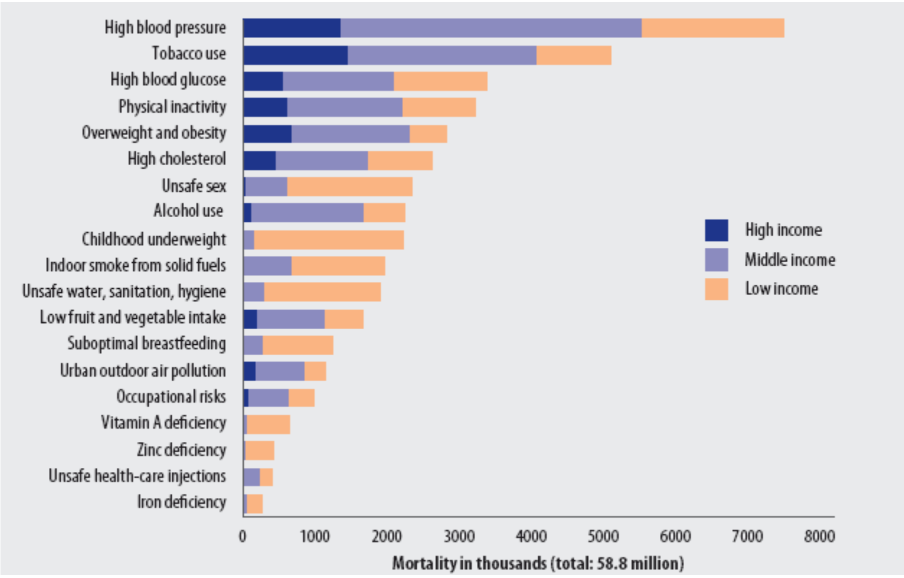


Source: https://healthcare.utah.edu/cardiovascular/conditions/coronary-artery-disease.php

Figure 1: Healthy heart artery compared to a blocked artery.

Peripheral vascular disease affects vessels in the legs and cerebrovascular disease affects blood vessels in the brain which also leads to stroke (Grochocinski, 2011). Authors opine that PI increase the levels of cholesterol, triglycerides and blood glucose in the blood, thereby increasing the chances of developing cardiovascular disease (Currier et al., 2008; Friis-Møller et al., 2007). Studies have shown that higher rates of cardiovascular disease are increasingly being reported in the PLWHA receiving ART (Grochocinski, 2011; Martinez et al., 2007; Sharma et al., 2014).

There are concerns that fewer PLWHA exercise, and studies have shown that 65% of those receiving ART for at least five years had a sedentary lifestyle (Romancini et al., 2012). Further, they identified a firm relationship amongst physical activity levels and advanced levels of high density lipoprotein-cholesterol (Romancini et al., 2012). The agreed recommendations for PLWHA include specific physical activities, taking sufficient intake of fruit and vegetables to address cardiovascular disease. (Romancini et al., 2012; World Health Organisation, 2015). The Figure below shows the deaths accredited to nineteen prominent risk causes by country income status according to (WHO, 2015).



Global Health Risks Mortality and Burden of Disease Attributable to Selected Major Risks (WHO, 2009)

Figure 2: Deaths accredited to nineteen prominent risk factors by country income status

Studies have shown that mortalities among PLWHA are increasingly a result of chronic diseases or non-communicable diseases (Barbaro and Barbarini, 2011; Bloomfield et al., 2014; Currier et al., 2008; Friis-Møller et al., 2007). In Zimbabwe, one study estimated that the prevalence of comorbidities (presence of other diseases occurring together with a primary disease) among PLWHA of male and female gender were at 15 and 5%, respectively and females recorded higher rates than males (Magodoro et al., 2016). The commonly observed individual chronic risks were hypertension, asthma, type 2 diabetes mellitus, cancer and congestive cardiac failure (Magodoro et al., 2016). It was also confirmed that the incidences of chronic diseases had increased over time due to urbanisation and the high HIV-infection rate in Zimbabwe (Zhou, Oktedalen, Chisango and Stray-Pedersen, 2016). The study identified HIV and chronic diseases as a potential recipe for disaster (Zhou et al., 2016).

The chronic diseases in PLWHA are presented in the form of enlarged central adiposity, peripheral lipoatrophy, peripheral insulin resistance, diabetes, dyslipidaemia and hypertriglyceridemia, overweight, obesity, osteoporosis and osteopenia, among others (Akl et al., 2017; Alonge et al., 2013; Crane et al., 2006; Erlandson et al., 2016; Grinspoon and Carr, 2005; Jaime et al., 2006; Junior et al., 2010; Malita et al., 2005; Neto et al., 2013; Zephy et al., 2015).

Although many of these adverse effects are treated, mostly by pharmacological means, it is less than ideal to continue relying on additional medications to address this epidemiological situation in the PLWHA receiving ART (Ciccolo et al., 2004). Patients with cardiovascular disease are encouraged to exercise for it is safe but should be adjusted according to the risk of cardiac-related event, musculoskeletal limitations, baseline exercise capacity and angina threshold (ACSM, 2014, p.236). Resistance exercise are an ideal intervention for cardiac conditions in the PLWHA (ACSM, 2014, p.252).

2.3. OVERVIEW OF INTERVENTIONS ADDRESSING ART SIDE EFFECTS IN PLWHA

Stanley and Grinspoon. (2012), state that long term treatment for body composition changes and cardio metabolic anomalies in PLWHA includes lifestyle modifications, the use of lipid-lowering proxies, insulin sensitisers and cures to reverse endocrine anomalies, including growth hormone-releasing hormone. The pharmacological redress for treating lipoatrophy is to shift PLWHA off thymidine analogues onto non-thymidine equivalents on condition that it does not jeopardise control of the individual's HIV-infection (Hubbard, 2007).

Murphy and McKay (2013) assert that, once a diagnosis of diabetes in PLWHA receiving ART is made, routine screening for the complications linked with diabetes should take place and plans should be made to improve glycaemic control. The study showed that such efforts are dependent on the healthcare systems and need a multidisciplinary approach in addressing the prevalence of diabetes in PLWHA (Murphy and McKay, 2013).

Junior et al. (2010) determined that efforts should be directed toward controlling modifiable chronic disease risks in PLWHA. Other researchers suggest giving lifestyle advice where appropriate, particularly with respect to tobacco use, alcohol abuse, exercise and dietary interventions (Compston, 2015; McComsey et al., 2010). Treatment with alendronate and vitamin D also appears to be effective (McComsey et al., 2010).

Hubbard (2007) recommended exercise because it can decrease abdominal fat than associated surgical interventions (liposuction of dorsocervical fat pads) which can offer temporary relief, since the fat accumulation tends to recur. In South Africa, Ogutibeju et al. (2007) went on to research the use of nutritional supplements to address body weight and body mass index in PLWHA. Significant results were evident and about 70% of participants had body mass indexes within the normal range after nutritional supplementation for three months (Ogutibeju et al., 2007).

In Zimbabwe, Mudzviti et al. (2012) examined the impact of herbal drug use on the adverse side effects of ART in PLWHA receiving first line treatment. The local herbs, Musakavakadzi and Peltoforum Africanum were taken together with ART and significantly reduced the incidence of chronic disease risks in the PLWHA (Mudzviti et al., 2012). Similarly, Jaime et al. (2006) supported the use of nutritional interventions after research suggested that they are beneficial for preventing central obesity among PLWHA receiving ART.

Treatment for glucose abnormalities (a chronic disease risk) in PLWHA is the same as in none HIV-infected individuals, with the use of insulin sensitising agents and/or sulfonylureas (Grinspoon and Carr, 2005). Body weight should be timeously checked and healthy lifestyle supervision encouraged such as dietary measures and regular exercise to limit concentrated sugar (Hubbard, 2007). The treatments for lipodystrophy, include changes in diet, engaging in specifically designed exercise regimens which influence muscle building and reduce fat accumulation (AIDSinfo, 2016). Exercise improves overall health and boosts a sense of well-being among the HIV-infected according to the Canadian AIDS Treatment Information Exchange guide (Lands, 2015). A strong body is better equipped to fight HIV and chronic disease risks, such as heart disease, diabetes and osteoporosis (Lands, 2015).

Furthermore, Lands (2015) stipulated that besides aerobic exercises, as recommended in AIDSinfo (2016), RE such as weight training, are particularly beneficial because they are the most efficient way to build healthy muscles. Monroe (2009) similarly advises diet, exercise, glucose monitoring, medications and smoking cessation as good self-care practices for PLWHA receiving ART. Stanley and Grinspoon (2012) recommend that more research is needed to develop collective strategies to improve body composition and eradicate chronic disease risks in PLWHA. In the midst of appraised interventions, exercise is a natural solution that appeals reasonably more as the next best option in addressing chronic disease risks among PLWHA.

Scholars concur that physical exercise is a natural intervention highly beneficial to PLWHA in alleviating identified chronic disease risks (Roubenoff and Wilson, 2001; Srikanthan and Karlamangla, 2014). In such instances the need for more medication to address chronic disease risks may be reduced or be strongly complemented with exercise. The overburdened, drug-dependent bodies of PLWHA stand to benefit from exercise interventions (Stanley and Grinspoon, 2012).

2.4. EXERCISE INTERVENTIONS FOR PLWHA

According to Malita et al. (2005), exercise training in particular helps in altering body composition patterns among PLWHA receiving ART. The use of RE and aerobic exercise has associated positive effects on insulin resistance, total and central body fat in PLWHA receiving appropriate ART (Hunter et al., 2010; Malita et al., 2005). Smith et al. (2001) points out that increased consideration has been directed towards exercise since it is a safe beneficial lifestyle addition in treatment of PLWHA. Ciccolo et al. (2004) consistently list exercise as one of the most recommended self-care therapies because it does not considerably increase circulating HIV-viral load or reduce CD4 counts. The study further stated that exercise improves the psychological condition of mood in PLWHA receiving ART (Ciccolo et al., 2004).

Zimbabwe generally lacks data on the use of exercises for PLWHA. Health-promoting behaviour and lifestyle changes involving exercise makes a difference in settings involving HIV, poverty and oppression (Myburgh, 2008). Bopp et al (2003) agrees that prolonged HIV-infection is linked with degeneration of muscles, tiredness, compromised functional capacity to work, depression, and declined quality of life, leading to frailty and mortality. It is noted that exercise can have a positive effect on many aspects of physical and mental health of PLWHA (Bopp et al., 2003). There is evidence that resistance and aerobic exercises offer physical and metabolic health benefits for PLWHA through developing aerobic capabilities, cardiorespiratory strength, muscular endurance and general wellbeing; while reducing the percentage body fat and metabolic consequences (ACSM, 2014, p.294).

2.5. ASSOCIATION OF THE EFFECTIVENESS OF RESISTANCE EXERCISE AND AEROBIC EXERCISE FOR PLWHA RECEIVING ART

Resistance exercise training offers the opportunity of improving strength in PLWHA. There seem to be inconclusive evidence on the most effective exercise modality that can be prescribed to PLWHA. The exercise prescription varies between exclusive RE, exclusive aerobic exercise and or combined exercise. In studying literature Hamid and Rajah (2015) assessed the effects of RE sessions on self-reported health-related quality of life, body composition and muscle strength among PLWHA. In their study participants, 14 were randomly allocated to an experimental group (the EXP group) exercising using elastic bands and 15 were assigned to a RE programme without elastic bands control group (the CON group). The participants in both groups completed exercise programmes for 12 weeks (Hamid and Rajah, 2015). The self-reported health-related quality of life, body composition and isometric shoulder lift strength were measured at baseline and at week 12.

In total, ten men (four experimental and six controls) dropped out of the programme. Participants in the CON group showed significant improvements in psychological health. Although no significant changes in all body composition factors were found in either group over time, but strength improved (Hamid and Rajah, 2015). The authors concluded that RE significantly improve shoulder lift strength and show positive effects on self-reported health-related quality of life scores among PLWHA (Hamid and Rajah, 2015).

Yarasheski et al. (2001) investigated the effects of 64 sessions of RE on 18 asymptomatic HIV-infected males without lipodystrophy, receiving ART. The variables examined were body composition (measured using dual energy x-ray absorptiometry), thigh muscle area (using axial proton-magnetic resonance imaging) and plasma lipids. Yarasheski et al. (2001) found that the lean body mass increased while trunk adipose mass and fasting triglycerides decreased significantly (Yarasheski et al., 2001). Blood cholesterol scores and fasting insulin levels did not change. The decreases in triglyceride levels were greatest in participants with peak baseline triglyceride levels. They also noted that increases in fat-free mass were associated with declines in fasting triglycerides (Yarasheski et al., 2001). This shows that RE programmes are effective lifestyle interventions in reducing wasting among HIV-infected men receiving ART; increasing muscle strength and clearing serum triglycerides (Yarasheski et al., 2001).

Souza et al. (2011) conducted a RE programme with eleven PLWHA. In their study they also had a CON group that was non-HIV-infected. All the participants were older than 60. This was a pre-post-test study. The participants trained twice a week, with supervision, for one year. In their reported results, the PLWHA had a smaller body mass index. The strength scores of PLWHA increased more than in the control group independent of gender, age or pre-test fitness level (Souza et al., 2011).

In a review study, Phillips et al. (2006) observed that PLWHA often experience a loss of lean muscle mass. The HIV-related wasting was seen to be correlated to in increased disease advancement and increased morbidity (Phillips et al., 2006; Wasserman et al., 2014). Dietary supplementation, cytokine reduction, hormonal treatment and RE training was identified as possible cures for this condition. Resistance exercise, which is more easily accessible to this population than other treatments, holds promise in counteracting the process of HIV wasting, as it has been successfully used to improve body compositions in healthy and clinical populations (Phillips et al., 2006).

In a systematic review conducted by Leach et al. (2015) resistance training alone increased body mass, sum of skinfolds and limb girths in PLWHA. It was shown that exclusive aerobic training improved body mass index, weight, waist-hip ratio and summation of skinfolds (Leach et al., 2015). The researchers found that combined resistance and aerobic training both addressed body mass and sum of skinfolds (Leach et al., 2015). In this review it showed that the benefits of exclusive resistance training may differ from those obtained from aerobic training alone and that full benefits of exercise are attained mainly through combined training. Leach et al. (2015) however points out that these findings need to be carefully deduced since there are few studies involving exclusive resistance training. The researchers recommended that there is need for future studies to be conducted which pay particular attention to sample size, women, follow-up as well as comprehensive statistical analysis (Leach et al., 2015). In some of the resistance training studies they reviewed it showed that frequency was three times a week with progression but exercise intensity and supervision was not specified hence no standard protocol were followed (Leach et al., 2015). Therefore, the training period ranged from 6 to16 weeks with volume set from 60 to 90% of 1RM undertaking 1 to 3 sets of 15 to 10 repetitions across the reviewed studies (Leach et al., 2015). Leach et al. (2015) concluded that body composition improves following safe application of exercises for they appear beneficial to PLWHA.

Grace et al. (2015) in a review study focused on exercise for PLWHA and showed that RE alone can increase muscle mass, leg or arm girths, strength and mitigate muscle wasting. In the reviewed studies improvements were also noted in glucose tolerance, percentage body fat, psychological status, insulin sensitivity and lipid profile (Grace et al., 2015). The identified resistance training exercises include resistance bands, weights, body weights, cables and plyometrics among others (Grace et al., 2015). The aerobic exercise training studies were also noted to have improved strength scores in PLWHA (Grace et al., 2015). This finding though is not specified on the type of strength referred to. The generally agreed frequency of exercise in the reviewed studies was three times a week although some recorded positive outcomes two times a week (Grace et al., 2015). In the review the aerobic exercise training intensity had a range of 50-90% of HRmax while for the resistance exercise was also 50–90% of 1RM over 45 minutes and 30–90 minutes respectively (Grace et al., 2015). In addition to a previous review conducted by Leach et al. (2015) it showed that Grace et al. (2016) agrees to the fact that combined aerobic and RE appears to be more effective than one component (aerobic or resistance). This could have been agreed to since in the review study the combined aerobic and resistance training exercises was noted to have improved functional ability, quality of life, decrease in fat percentage, abdominal fat, increase in body mass index, muscle mass, viral load, cell counts as well as improvement in lipid profile and glucose tolerance (Grace et al., 2015).

Grace et al. (2015) confirmed that resistance exercise is a safe non-pharmacological therapy and effective in PLWHA. However, Lopez et al. (2015) contented that although exercise interventions have renowned appeal they have not been comprehensively used or globally accepted as a valuable option for PLWHA. In line with the notion of agreeing to the fact that combined aerobic and resistance exercise have a more benefit; Gomes-Neto et al. (2015) conducted a meta-analysis study to find its effects on exercise capacity, strength and quality of life in PLWHA. The findings from the studies reviewed showed that the aerobic component had an intensity range of 50-80% of HRmax, 2-3 times a week lasting for 30-90 minutes over a 6-24 weeks, while the resistance element was set at a range of 60-80% of 4-12RM assuming the same frequency and time as the aerobic component (Gomes-Neto et al., 2015). It showed that more of these studies were conducted under supervision than those without supervision (Gomes-Neto et al., 2015). The results showed that there were improvements in maximum oxygen consumption, muscle strength (up to 25.06kg for knee extensors and 4.44kg for elbow flexors), health-related quality of life, improving the ability to undertake daily activities compared to control group (Gomes-Neto et al., 2015).

The researchers admitted that they did not compare aerobic or resistance exercise alone to combined aerobic and resistance exercise for they were still not sure of the most ideal exercise modality among the three (Gomes-Neto et al., 2015). It was recommended that further resistance exercise researches be conducted so as to highlight it as the next best natural health-care management option for PLWHA (Gomes-Neto et al., 2015). In conclusion Gomes-Neto et al. (2015)advised that the exercise instruction should match the medical characteristics of PLWHA in determining the most appropriate FITT (frequency, intensity, time and type) dosage in achieving peak maximum oxygen consumption and quality of life outcomes (Gomes-Neto et al., 2015).

A latest systematic review and meta-analysis study showed that only eight studies out of 20 focused on exclusive resistance exercise and 12 of the studies had included aerobic and resistance exercise combined over duration of 6-52 weeks (O'Brien et al., 2017). The results showed that improvements were noted in maximum oxygen consumption, exercise time, strength, body composition and weight compared to control group but greater improvements in weight and body composition were in studies involving resistance exercise alone than in aerobic exercise component (O'Brien et al., 2017). The health-related quality of life improved compared to control group although no much changes were noted in CD4 count and viral load (O'Brien et al., 2017). The study affirmed that it is safe to perform any of the three exercise modalities for three times per week over six weeks leading to improvement in maximum oxygen consumption, body composition, strength and weight in PLWHA (O'Brien et al., 2017). In this review and analysis it was noted that no studies were found that researched on the effect of exclusive resistance exercise on PLWHA in developing nations (O'Brien et al., 2017). Although in West Africa and SSA there has been some emergence of similar studies (O'Brien et al., 2017). In Zimbabwe Mkandla et al. (2016) undertook the only one exclusive resistance exercise study conducted two times a week over 12 weeks and noted improvements in quality of life among PLWHA related distal symmetrical poly-neuropathy compared to the CON group. This underscores the role of resistance exercise studies further than the confines of developed nations (O'Brien et al., 2017). The reaffirmation is that exclusive resistance exercise is safe and valuable for PLWHA (O'Brien et al., 2017).

Gomes-Neto et al. (2013) in a systematic review study found that resistance exercise alone improved muscle strength and body composition more than quality of life in PLWHA while aerobic exercise improved maximum oxygen consumption and body composition. Longer durations at moderate intensities involving combined resistance and aerobic exercise were found to be essential in improving assessed variables (Gomes-Neto et al., 2013).

The studies reviewed varied in the sample sizes as well as the inclusion of male and female participants. The exclusive resistance exercise studies had a final sample of 20 to 50 participants with a duration range of 6-16 weeks of which 40% of the studies only applied 12 weeks (Gomes-Neto et al., 2013). The other studies did not report about the study duration altogether. The resistance exercise targeted major muscle groups involving the use of weight stations, machines and free weights based on each participant's 50-90% of 1RM (Gomes-Neto et al., 2013). The outcome of exclusive RE included increased muscle strength, lean body mass, mid-thigh girth, done mineral density and decrease in body weight besides a minimal effect on quality of life (Gomes-Neto et al., 2013).

The exclusive aerobic exercise studies had a final sample range of 18 to 109 participants with most of the studies recruiting both men and women over 6 to 24 weeks although 60% of studies lasted for 12 weeks. The majority of the studies used combined exercise programmes or cycle ergometer at an intensity adjusted at 50-80% of HRmax (Gomes-Neto et al., 2013). The related body composition outcomes and maximum oxygen consumption improved while reductions in body weight, total body fat and the waist-to-hip ratio scores were recorded (Gomes-Neto et al., 2013). Contrary to exclusive resistance or aerobic exercise outcomes, combined aerobic and resistance exercise further improved thigh muscle volume, effect on quality of life and reduced thigh muscle adiposity, percentage body fat as well as exercise duration (Gomes-Neto et al., 2013).

The decrease in strength may be in part associated with decreases in lean body mass according to disease progression (Quiles and Ortiz, 2017). RE improves protein synthesis there by increasing muscle mass, strength and muscle mass in PLWHA. Quiles and Ortiz (2017) allude to a study they reviewed involving male participants with muscle wasting and performed RE 3 times per week, completing 3 sets of each exercise at 75-80% of 1RM over 8 weeks. These men were compared to those without wasting. The results showed that strength and lean body improved more in men with muscle wasting (60% and 5.3%) than those without (44% and 2.3%) respectively (Quiles and Ortiz, 2017).

Quiles and Ortiz (2017) cited another study that compared the effects of exclusive RE, RE together with testosterone and RE with a placebo on HIV diagnosed men over 16 weeks. The exclusive RE was performed 3 times per week using light, medium and heavy training days tolerating intensities ranging from 70-90% of 1RM (Quiles and Ortiz, 2017). Similarly lean body mass and strength scores improved in exclusive RE at 2 kg and 22–23% (Quiles and Ortiz, 2017).

Improvements were also noted in RE plus testosterone giving evidence that exclusive RE is more or less equally effective (Quiles and Ortiz, 2017). In men who had experienced muscle wasting it showed that lean body mass increases were related to marginal improvements in day to day activities (Quiles and Ortiz, 2017). In a study with a different gender involving a sample of all women diagnosed with HIV over 16-week s was also referred to by (Quiles and Ortiz, 2017). The exclusive RE programme was home-based training 3 times per week at a range of 60-80% of 1RM progressively (Quiles and Ortiz, 2017). The improvements in strength (at the knee, ankle, shoulder and elbow muscles) and lean muscle mass were noted (Quiles and Ortiz, 2017). Another study with all women diagnosed with HIV and performing RE 3 times a week over 14 weeks was conducted in a hospital setting (Quiles and Ortiz, 2017). The exercise routine was performed in a circuit format with a multi-station machine at 50-70% of 1RM progressively and the women had improved fat mass (by 2.5kg), lean body mass (by 0.6kg) and health-related quality of life in vitality as well as health perceptions (Quiles and Ortiz, 2017).

Quiles and Ortiz (2017) further cited a study conducted by Garcia et al. (2014) in which a 20 week combined aerobic (30 minutes at 60–75% of the maximal oxygen uptake) and circuit resistance training exercise (3 days a week using 12-15 repetitions per exercise three days per week) was undertaken on PLWHA. The findings showed an improvement in lean body mass of 1.8kg and muscular strength (Quiles and Ortiz, 2017). The study concluded that RE seem effective when conducted exclusively or in a circuit or in combination with an aerobic component (Quiles and Ortiz, 2017). Cardiovascular diseases can increase in PLWHA receiving ART if lipids and glucose disorders are not managed (Quiles and Ortiz, 2017). Importantly some studies reviewed showed that exclusive RE can efficiently improve blood lipid, glucose and bone metabolism and muscular strength in 16 weeks, at 50 to 80% of 1RM in PLWHA (Quiles and Ortiz, 2017). In Quiles and Ortiz (2017) they referred to a reviewed study and found out that fasting blood glucose decreased following a RE programme conducted 3 times a week at 80% of the 1RM over a 24-week period with PLWHA. It was also noted that improvements in blood lipid concentrations may change following a12 week RE programme for PLWHA

Quiles and Ortiz (2017) again reviewed that RE conducted 3 times a week at 70 and 80% of the 1RM over 12 weeks on PLWHA with lipodystrophy improves bone mineral density in the backbone (by 3.28%), femoral neck (by 8.45%), and radius (by 5.41%) . RE should be prioritized since there is strong evidence to suggest that some ART drugs cause a decrease in mineral bone density leading to functional impairments and osteoporotic fractures (Quiles and Ortiz, 2017).

A major knowledge gap was that there were no studies identified by Quiles and Ortiz (2017)that had been conducted to compare different RE volumes and intensities in PLWHA at the time of review in determining the most effective dose. The studies have shown that with HIV-infection, loss of muscle affects strength and the only anabolic treatment to improve lean body mass and strength is RE training. This supports the idea that maintaining a desirable adipose-lean tissue ratio restores body weight and muscle mass to normal or desirable body composition levels (Anderson, 2006). Therefore, RE improves health-related quality of life, body composition scores, strength and physical functioning, (Hamid and Rajah, 2015; Mkandla et al., 2016; Roubenoff and Wilson, 2001; Souza et al., 2011; Walker et al., 2013; Yarasheski et al., 2001). Resistance exercise has great potential to be a sustainable substitute to pharmacological cures for preserving and improving muscle mass and strength in PLWHA (Dudgeon et.al., 2006).

Scholars confirms that there is less data on the effect of RE in PLWHA (ACSM, 2014, p.293). It is recommended that RE programmes for PLWHA should be supervised and be performed two to three days a week; at an intensity of 8-10 repetitions, at about 60% of 1RM and completing two to three sets of 10-12 exercises in 30 seconds (ACSM, 2014, p.294). It is important to note that RE may be varied depending on the interest and health status of the PLWHA (ACSM, 2014, p.295).

The literature shows that RE are beneficial for PLWHA. The studies give evidence that RE has potential to address issues of total blood cholesterol, blood glucose, blood pressure, body composition and strength in PLWHA. There is limited data in the use of RE for PLWHA and hence more need for such studies be held in Africa.

CHAPTER THREE: ARTICLE 1 - SYSTEMATIC REVIEW

BODY COMPOSITION RESPONSES TO RESISTANCE EXERCISE AND AEROBIC EXERCISE INTERVENTIONS IN PEOPLE LIVING WITH HIV/AIDS (PLWHA) RECEIVING ANTIRETROVIRAL THERAPY (ART)

Victor Mbayo [1†*], Takshita Sookan [1, †,*]

[1] Discipline of Biokinetics, Exercise and Leisure Sciences, School of Health Sciences, University of KwaZulu-Natal, South Africa; e-mail: vmbayo@gmail.com

[1] Discipline of Biokinetics, Exercise and Leisure Sciences, School of Health Sciences, University of KwaZulu-Natal, South Africa; e-mail: Sookan@ukzn.ac.za

† These authors contributed equally to this work.

* Author to whom correspondence should be addressed; e-mail: vmbayo@gmail.com; and Sookan@ukzn.ac.za

Phone: +263 772 430 126, +27 31 262 1468, Fax: (031) 262 6803

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3.1. ABSTRACT

Human Immunodeficiency Virus (HIV) related mortality rates are a cause of concern the world over. Prompt initiation of antiretroviral therapy (ART) is advisable once diagnosed HIV-positive. The advent intake of ART has increased life expectancy for people living with HIV and AIDS (PLWHA). The PLWHA now live longer to the extent of acquiring lifestyle/non-communicable conditions. The PLWHA receiving ART may then experience a reduction in general strength which limits bodily functioning, alterations to composition scores and reduced activity levels. Physical exercise intervention strategies are largely being used to alleviate the negative effect of ART on PLWHA. There is limited data on use of resistance exercise (RE) and aerobic exercise interventions for PLWHA. This article systematically reviews resistance exercise (RE) and aerobic exercise intervention strategies and how they affect body composition, chronic disease risks and strength scores in PLWHA receiving ART.

KEY WORDS: HIV, ART, body composition, resistance exercise, aerobic exercise

3.2. INTRODUCTION

The prevalence of HIV rates remain extraordinarily high (UNIAIDS, 2015). Treatment regimens of ART reduce HIV associated mortality (Walker et al., 2013). The PLWHA receiving ART suffer from chronic disease risks at almost the same rate as the general population presenting multiple burdens (Barbaro and Barbarini, 2011; Bhatia et al., 2011; Greenland et al., 2003; Mgunya, 2012; Post, 2012; Syed and Sani, 2014; Shields et al., 2012; Singh et al., 2013; Stein, 2010; Yusuf et al., 2001) . Non-communicable ailments are now the leading cause of non HIV-related deaths in PLWHA (Hadigan et al., 2003; Post, 2012). The chronic disease risks in PLWHA receiving ART include, but not limited to bone fractures, hypertension, diabetes mellitus, a high total blood cholesterol leading to premature deaths in some circumstances (Mgunya, 2012).

The PLWHA experience wasting syndrome, decreases in caloric intake along with a loss of lean body mass (Anderson, 2006). It is affirmed that a decrease in physical activity and nutritional intake causes wasting syndrome (Anderson, 2006). PLWHA receiving ART may further experience activity limitations and participation restrictions/disabilities involving routine obligations like shopping, cooking and housework (Mlambo, 2011).

An increased risk for developing cardiovascular events associated with lipodystrophy syndrome emerges once PLWHA initiate ART, (Barbaro and Barbarini, 2011). Lipodystrophy is mainly caused by the specific action of antiretroviral drugs on the metabolic system especially protease inhibitors (Pi) (Barbaro and Barbarini, 2011). HIV-associated lipodystrophy syndrome and related cardiovascular risks have increasingly become clinical entities in developed and developing countries alike (Barbaro and Barbarini, 2011). Significantly, ART is associated with increased levels of triglycerides, body mass index and type 2 diabetes (Mgunya, 2012). There is a direct increase in chronic disease risk factors with duration on treatment generally from two years onwards (Dolan et al., 2005; Mgunya, 2012; Shields et al., 2012; Singh et al., 2013). Research in America revealed that 10% of PLWHA had recently been detected with cardiovascular disease (Syed and Sani, 2014). The prevalence of cardiomyopathy being the most common HIV-related presentation followed by pericardial disease and hypertension (Syed and Sani, 2014; . Studies have examined the effect of RE interventions in mitigating chronic disease risks (Bhatia et al., 2011). It shows that RE based interventions offer significant health benefits to PLWHA receiving ART though in some cases show varying outcomes of the same variables under study (Bhatia et al., 2011). The studies include RE interventions in combination with nutritional or pharmacological or aerobic exercise components while others involve exclusive RE without a co-intervention (Yarasheski et al., 2001).

Chronic disease risk, anthropomorphic and metabolic complications associated with PLWHA receiving ART have become possible prime targets for RE interventions, (Ciccolo et al., 2004). Studies on RE prescription largely conform to a dose equivalent to a frequency of between two to three days per week, performing eight to ten repetitions, targeting 10-12 muscle groups, undertaking two to three sets and at 60-80% of individual's 1RM according to ACSM (2014, p.294). Resistance exercise studies involving nutritional, pharmacological, aerobic exercise and solely RE interventions purportedly point out improvements in body mass index, fat mass, lean mass, thigh muscle circumference, total body water, decreases in visceral adiposity, resting energy, improved strength, fitness and quality of life (Yarasheski et al., 2001). However, study results among researchers vary regarding effects of RE on fasting blood glucose, insulin, cholesterol and CD4+ counts (Agin et al., 2001). The aim of this systematic review was to examine whether RE and aerobic exercise interventions on PLWHA are effective in reducing the effects of chronic disease risks, body composition and strength scores.

3.3. METHODOLOGY

3.3.1. LITERATURE REVIEW AND STUDY SELECTION

The method to retrieve articles was through searching web based databases included PUBMED, Googlescholar, MEDLINE and Cochrane Database Register of Controlled Trials to retrieve published research literature on subject matter under review. Key search words that were not limited to, “HIV”, “ART”, “Body Composition”, “Strength”, “Chronic Disease Risk”, “Resistance Exercise” , “ Aerobic exercise” and “Physical Activity” in order to retrieve relevant articles. The search was conducted in December 2016. The sought literature constituted of articles and abstracts covering the period January 2006 to December 2016. Manual handsearching of reference lists and table of contents of relevant journal articles were carried out to incorporate applicable studies that could have been possibly missed for inclusion.

The process enabled further searching of non-indexed relevant information in other databases. Eligible selected articles were individually vetted for inclusion depending on relevance, founded on a pre-established inclusion and exclusion criteria (*below*). Whereupon, indecisiveness concerning inclusion matters emanated, consultations with second and third researchers were conducted to decide on inclusivity or exclusivity of an article. Study discussions with second and third researchers were also held concerning other desired characteristics existing in retrieved publications like study design, homogeneity in study samples, availability of data on reliability of RE interventions and variable outcome measures. However, the pre-established inclusion criteria remained applicable.

3.3.2. INCLUSION/EXCLUSION CRITERIA

Design: The analysis was restricted to manuscripts using human subjects, random controlled trials, pre and post-test studies, English language published peer reviewed journals, RE intervention studies and RE intervention studies in combination with other co-interventions like nutrition, diet, aerobic exercise and pharmacological intervention. Summary of the studies included for review are listed in table 7. A total of 43 studies were excluded from analysis due to inconsistencies. This included studies that were non-randomised control trials, without pre and post-test, not published in peer reviewed journals, having participants < 18 years of age, studies focusing on other exclusive interventions without a RE component.

Participants: Studies with males and females between the ages of 18 – 46 years were included. Studies only looking at children <18 years or adults >46 years were excluded regardless of gender.

Outcome Measures: Studies were only included if body composition, chronic disease risks and strength (1RM) variables were pre-and-post measured. Further, studies including outcome measures such as health related quality of life, fitness, VO_2 max, limb circumferences, CD4+, CD8+, insulin sensitivity, self-efficacy, bone density, resting energy and total body water in addition to the aforementioned were also included.

Studies included were those that used different data collection instruments not limited to dual-energy X-ray absorptiometry, skinfolds measurements, CT scanners, Kasch pulse recovery test, electron beam tomography, 1RM, homeostatic model assessment and hyperinsulinemic glycemic clamp to establish outcome variable measures. Studies that involved different types of RE exclusively or in combination with aerobic exercises and or nutrition, or pharmacological interventions were included. The figure below shows the processes followed to consider articles for inclusion in the study:

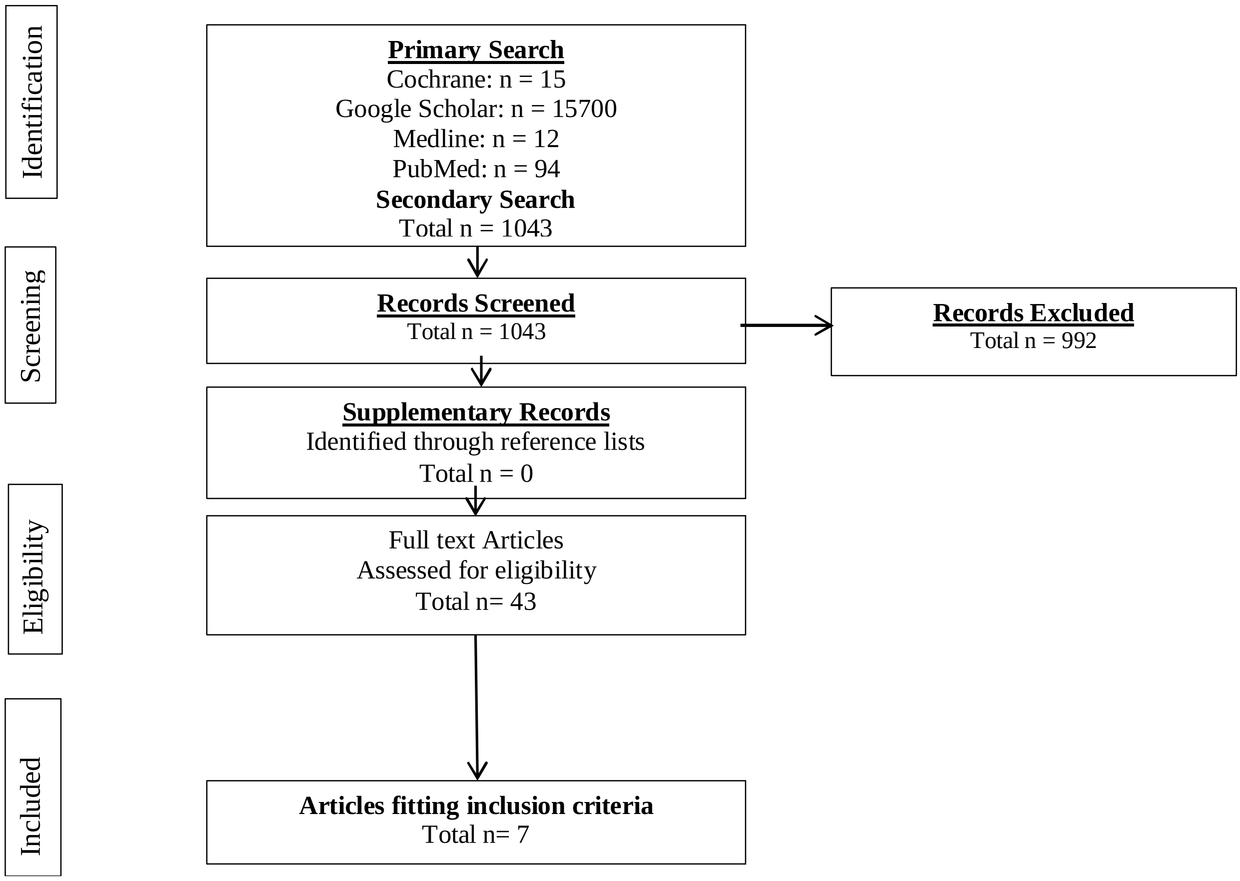

Figure 3: Schematic representation of the selection process for articles included in the systematic review

3.4. RESULTS AND DISCUSSION

3.4.1. STUDY CHARACTERISTICS

There were seven published studies that meet the inclusion criteria (see table 7 for study details). The number of participants in each study ranged from 20-221. Study participants were either males or females between the mean ages of 18-45 years. Four studies recruited both male and female participants (Balasubramanyam et al., 2011; Cade et al., 2013; Mendes et al., 2013; Yarasheski et al., 2011), while three recruited men exclusively (Dudgeon et al., 2010; Fillipas et al., 2006; Troseid et al., 2014).

None of the studies exclusively recruited female participants. In the studies that recruited both males and females: one study included sedentary participants (Mendes et al., 2013) while the other three studies made no mention of the exercise background of participants. In two of the studies involving males only, they mentioned that the subjects had a sedentary lifestyle (Dudgeon et al., 2010; Troseid et al., 2014).

In total, across the seven studies, three included sedentary participants and four did not specifically mention exercise backgrounds of recruited participants. In four of the studies they experienced participants dropout ranging from 1-30 participants (Balasubramanyam et al., 2011; Cade et al., 2013; Fillipas et al., 2006; Mendes et al., 2013), however three studies did not mention about dropouts.

None of the studies mentioned gender differences in response to resistance exercise interventions. The study period extended from a minimum of six weeks to a maximum of nine months across the seven studies that met inclusion criteria.

Studies included were those involving varied RE prescription dosages in combination with co-interventions and none were exclusive RE. The co-interventions to RE dosages in the seven studies included:

Aerobic at 60-75% of maximum heart rate and resistance at 60-80% of 1RM, performing ten reps, with two seconds rest, one to two minutes between sets, two to four minutes between exercises (Fillipas et al., 2006);

Aerobic exercise progressively increased from 50-80% of heart rate reserve and RE three sets of eight to ten reps up to 80% of 1-RM (Mendes et al., 2013);

Aerobic exercise or endurance training and RE supervised strength exercises (Troseid et al., 2014);

Aerobic exercise 30min of 60-65% of age related heart rate and RE 30min, one set of 12 reps for nine selected upper and lower body muscles at 60% of 1-RM (Dudgeon et al., 2010);

Diet, nutritional and pharmacological involving pioglitazone 30mg/d for four months, progressive aerobic conditioning at 50-85% of heart rate reserve and RE of 90-120min/day, three days a week, four upper body and three lower body exercises (Cade et al., 2013);

Pioglitazone 30mg/d, aerobic exercises 1.5-2hours/day, three days per week at 50-58% heart rate reserve, RE 8-12 repetitions on any exercise and diet weight maintenance diet 25% carbohydrates per day with protein 12%, carbohydrate 55% and 33% fat calories (Yarasheski et al., 2011);

Diet low saturated fat, cholesterol not more than 200mmol/l, fiber 20-30g/d, niacin , fenofibrate, aerobic exercise three times per week for 75-90 mins, RE three times per week according to ACSM guidelines (Balasubramanyam et al., 2011).

The diverse RE protocols are summarized in Table 7. In these selected studies, four of the studies involved control (CON) and experiment (EXP) groups; three of the studies used a range of three to five groups, (Balasubramanyam et al., 2011; Dudgeon et al., 2010; Mendes et al., 2013). All studies were random controlled trials.

There were three studies that mentioned the particular types of RE participants performed including [squat, bench press, hamstring extension, back pulley, knee flexion and calf on bench], (Mendes et al., 2013), chest press, leg press (Dudgeon et al., 2010), pull down, elbow flexion, shoulder raise, knee extension, knee flexion, chest press, and abdominal exercises (Fillipas et al., 2006).

Various research variables were measured across the seven studies which included: chronic disease risks such as blood pressure, blood glucose, total cholesterol, cardiorespiratory fitness, insulin-mediated glucose uptake, lipopolysaccharide, insulin sensitivity, myocardial insulin sensitivity, quality of life, self-efficacy, heart rate, endocrine and liver lipid content, (Balasubramanyam et al., 2011; Cade et al., 2013; Dudgeon et al., 2010; Troseid et al., 2014; Mendes et al., 2013; Yarasheski et al., 2011); anthropometry, skinfolds, arm muscle area, (Mendes et al., 2013 and Yarasheski et al., 2011); strength, (Mendes et al., 2013); body composition variables such as waist measurement, body mass index, body fat distribution, waist and hip circumference, fat and fat-free mass, abdominal subcutaneous tissue, visceral adipose tissue, (Balasubramanyam et al., 2011; Cade et al., 2013; Troseid et al., 2014; Mendes et al., 2013); CD4+ count, HIV-1 viral load (Balasubramanyam et al., 2011; Troseid et al., 2014); adiponectin C-reactive protein, energy expenditure, high-sensitivity C-reactive protein ,(Balasubramanyam et al., 2011) ; circulating hormones and cytokines, (Dudgeon et al., 2010) and safety parameters, (Yarasheski et al., 2011). The following table shows the studies that were included for this review.

Table vii: A Summary of studies included in the review

REF	Participants	Protocol	Co-Intervention	PRE/POST TEST	STUDY DESIGN
Fillipas at al, 2006	40 subjects ,5 drop outs, men	EXP group took part in a supervised aerobic and resistance exercise programme 2 times/wk, for 6 months. Goal 80% of 1RM, 3 sets 8 reps, 2 times a week, 30-60 minutes. The CON group participated in an unsupervised walking programme and attended group forums monthly.	Aerobic	Pre and post	Randomized control trial,
Dudgeon, et al 2010	HIV-infected men, Exercise-naïve. 14 in MOD group (44.3 ± 8.3yrs) and 11 in LOW group (42.9 ± 7.5yrs) and 13 in the CON group (44.5 ± 7.3 years) African American	MOD Grp: A moderate-intensity group (MOD) completed 30 min of moderate-intensity aerobic training 60%–65% of age related HR, and 30 min resistance training i.e. 1 set of 12 repetitions of 9 selected upper-body and lower-body resistance exercise with resistance set at 60% of the estimated 1-RM. LOW Intensity Grp (LOW), completed 60 min treadmill walking at 50% of age-predicted maximal HR. CON Grp: Participated in no activity i.e. remained seated in the facility for 60 min and participated in no physical activity.	Aerobic exercise	Pre and mid post and post-test.	3 Groups Randomized Control Experimental Design.
Yarasheski at al, 2011	44 subjects,39 completed, HIV-infected men and women (18–60 yr old), with insulin resistance/ IGT and central adiposity, Pioglitazone group 44 years+/- 2, Piogliterzone and exercise group 46 years +/- 2	4 mo of pioglitazone (pio; 30 mg/day) Group or Pioglitazone plus exercise training Group 1.5–2 h/day, 3 days/wk., of supervised, progressive, combined aerobic conditioning exercising at 50–85% HR reserve and resistance training firstly at one to two sets of each exercise while lifting a weight that caused muscle fatigue/failure after eight repetitions until they were conditioned to12 repetitions on any exercise. On diet for a weight-maintaining diet that contained adequate amounts of energy and macronutrients: 250 g carbohydrate/ day and 12% protein, 55% carbohydrate, and 33% fat calories.	Aerobic Pioglitazone	Pre and post	Random control trial

REF	Participants	Protocol	Co-Intervention	PRE/POST TEST	STUDY DESIGN
Balasubramanyam et al,2011	Hypertriglyceridemic patients 21-65 years, 221 subjects (mixture of males and females), 30 withdrew, 87% were males, 46% Hispanic, 36% white, 17% African American	Usual Care Gr 1 receiving heart healthy diet and fitness advice. Usual Care Group 1, Low saturated fat diet and exercise Group 2, Diet + Exercise (D/E) + Fenofibrate Grp 3, Diet + Exercise (D/E) + Niacin Group 4, D/E + Fenofibrate + Niacin Group 5. Groups 2-5 were taught a weight maintaining diet 50% calories from CHO, 30% from fat, cholesterol not more than 200mg/d, fiber 20-30g/d, participated in an exercise programme according to ACSM guidelines 3 times per week 75-90min Aerobic and Resistance exercise over 24 weeks, in addition to diet and exercise Fenofibrate was given to Grp 3, Niacin to Grp 4, Fenofibrate + Niacin to Grp 5.	Diet Drugs – Fenofibrate, Niacin Aerobic exercises	Pre, multi-mid post and post test	5 Group, Randomized, double blind, placebo controlled
Mendes et al., 2013	99 PLWHA were randomly allocated into 4 groups, 29men (39.7 +/- 9.3 years) and 51 women (38.8 +/-11.6 years). Sedentary for at least six months prior to the on ART for about 1 year and indicated no contraindications for physical exercise. 19 dropped from the study.	24 weeks of RE with aerobic component (REAC). Grp 1: exercise and lipodystrophy (n = 24; EX + LIP); Group 2: exercise without lipodystrophy (n = 21; EX + NoLIP); Group 3: control and lipodystrophy (n = 27; NoEX + LIP); Group 4: control without lipodystrophy (n = 27; NoEX + NoLIP).Performed 3times/week in non-consecutive days. Warm-up and stretching exercises (10 min), aerobic training (15-20 min), and resistance training (40 min) before return to calmness (10 min). The REAC started after interpretation of 1-RM and 20mMST results. Resistance Ex 3 sets of 8-10 repetitions, at 80% of 1-RM i.e. 6 exercises squat, bench press, hamstring extension, back pulley, knee flexion, calf on bench. Aerobic based on the reserve heart rate on treadmill or cycle ergometer, according to individuals' adaptation, with intensity increase range from 50 to 80% of HRres monitoring heart rates.	Aerobic	Pre and post	Random control trial

REF	Participants	Protocol	Co-Intervention	PRE/POST TEST	STUDY DESIGN
Cade et al., 2013	24 HIV+ adults with peripheral metabolic complications like peripheral insulin resistance. PIO, 25% of the participants were women; 42% were African American, and 58% were Caucasian. 20 subjects completed the study. EXS, all participants were males; 38% were African American, 25% were eastern Indians, and 37% were Caucasian. Four participants dropped out.	PIO GRP : 4 months of pioglitazone (PIO; 30 mg/d) or supervised, EXS GRP: Progressive Resistance Exercise training (EXS; 90–120 min/d, 3 d/wk) 4 upper and 3 lower body exercises at increased individual's %1RM. Combined with progressive endurance or aerobic conditioning (HR range of 50% to 85% HR reserve)	Pioglitazone Progressive Aerobic Training	Pre and post test	2-Group, Random Assignment Study
Troseid et al., 2014	20 sedentary middle-aged HIV-infected men on ART and with lipodystrophy. 14, age and VO_2 max matched HIV-seronegative healthy men were control group.	Supervised strength Group Endurance training Group 3 times per week for 16 weeks.	Aerobic/Endurance training	Pre and post test	2 Group, Randomly Assigned

3.4.2. RESULTS OF RESISTANCE EXERCISE INTERVENTIONS IN PLWHA

3.4.2.1. EFFECTS OF RE INTERVENTIONS ON BODY COMPOSITION

Three studies noted improvements in body compositions scores in PLWHA following RE (Troseid et al., 2014; Mendes et al., 2013 and Yarasheski et al., 2011). In one study by Mendes et al. (2013) they established that, body circumferences and waist-to-hip ratio significantly changed after 24 weeks of RE and aerobic conditioning. The sum of seven skinfolds, percentage body fat, total fat, central fat and peripheral subcutaneous fat similarly decreased in response to RE and aerobic conditioning. Meanwhile, the muscle mass increased in exercised groups (Mendes et al., 2013).

Troseid et al. (2014) discovered that, although body mass index (23.4 vs. 24.0 kg/m^2) and trunk fat mass reduced, the variables did not significantly change following strength training. Yarasheski et al .(2011) confirmed noting decreases in total body and limp adipose tissue.

3.4.2.2. EFFECTS OF RESISTANCE EXERCISE INTERVENTIONS ON CHRONIC DISEASE RISK INDICATORS

In five studies researchers noted improvements in chronic disease risk indicators following RE interventions (Yarasheski et al., 2011; Fillipas at al., 2006; Yarasheski at al., 2011; Balasubramanyam et al.,2011; Cade et al., 2013; Troseid et al., 2014) . In the study conducted by Troseid et al. (2014) there were reductions in triglyceride and lipopolysaccharide levels reduced by 9.6% (−5.0% to −14.7%, P = 0.0001) for each unit reduction in triglycerides in the strength training group. Insulin sensitivity after strength training improved while increases in insulin-mediated glucose uptake were noted following strength and endurance training (Troseid et al., 2014).

Balasubramanyam et al. (2011) investigated the effect of fenofibrate, niacin, diet and exercise (aerobic and RE) on PLWHA. The researchers established that the intervention reduced triglycerides (-52%), increased high density lipoprotein-cholesterol (+12%) and decreased non- high density lipoprotein-cholesterol (-18.5%) and (-24.5%) total blood cholesterol to high density lipoprotein-cholesterol ratio (Balasubramanyam et al., 2011).

Cade et al. (2013), investigated the effect of progressive resistance exercise combined with progressive endurance in the CON group receiving supervised 3mol of pioglitazone. There were minor increases noted in fasting blood glucose, insulin, triglycerides, and total and low-density lipoprotein in the exercise group. Also, basal myocardial insulin sensitivity non-significantly increased, while myocardial fatty acid metabolism and utilization rates increased but not significantly. However, resting systolic and diastolic blood pressure was unchanged (Cade et al., 2013).

Dudgeon et al. (2010) carried out a study involving a moderate intensity (resistance and aerobic) exercising group, low intensity (aerobic) exercise and the CON group (no exercise). Results showed that at post-exercise period, the moderate intensity exercising group had 135% increases in growth hormone, 34% decrease in cortisol. A 31% increase in interleukin-6 at 30-min post exercise and 23% increase in interleukin -6. At 60- min post exercise a 13% decrease in soluble proteins was noted (Dudgeon et al., 2010). The low intensity exercising group had a 3.5% decrease in soluble tumor necrosis factor receptor 2 at 30-min post exercise compared with baseline and a 49% decrease in growth hormone at 60-min post exercise (Dudgeon et al., 2010). The CON group had a decrease in growth hormone at 62% and 61% at 30-min and 60-min respectively post-exercise compared to pre-test (Dudgeon et al, 2010).

Yarasheski et al. (2011) studied the effect of pioglitazone, combined (aerobic exercise and RE) exercise and diet in PLWHA. The training group was noted to have improved peripheral insulin sensitivity, decreased liver lipid content and fasting low density lipoprotein. However, high density lipoprotein-cholesterol concentrations were not changed (Yarasheski et al., 2011).

3.4.2.3. EFFECTS OF RESISTANCE EXERCISE INTERVENTIONS ON STRENGTH IN PLWHA

Mendes et al. (2013) affirmed that strength increased while on the other hand Fillipas et al. (2006) confirmed that cardiorespiratory fitness increases in response to RE and aerobic conditioning. According to Cade et al. (2013) the whole-body peak oxygen consumption increases, although not significantly. The following table shows results of the effects of RE and aerobic exercise studies in PLWHA.

Table viii: Results of the effects of RE interventions on PLWHA

REF	Study Variables	Results	Differences among study groups
Fillipas at al. (2006)	Self-efficacy using General Self-efficacy scale, Cardiovascular fitness, using Kasch Pulse recovery test, health related quality of life using medical outcome study HIV health survey.	EXP group improved their self-efficacy by 6.8 points (95% CI 3.9 to 9.7, p<0.001), improved cardiovascular fitness by reducing their heart rate by 20.2 bpm (95% CL – 25.8 to 14.6, P < 0.001). Health related Quality of life improved in only two out of 11 dimensions i.e. in EXP group they improved overall health by 20.8 points, their cognitive functioning by 14 points.	Improvements in cardiovascular fitness, Q.OL and cognitive functioning in EXP group was more than in the CON group
Dudgeon et al. (2010)	Circulating anabolic and catabolic factors i.e. Blood and saliva samples or circulating hormones and cytokines	At the post time point MOD group had an increase of 135% in growth hormone (GH), 34% decrease in cortisol (CORT), At min post exercise a 31% increase in interleukin-6 (IL-6) at 30-min post exercise and 23% increase in IL-6, At 60-min post exercise. a 13% decrease in soluble tumor necrosis factor receptor 2 (sTNFrII). Increases in lean tissue mass The LOW group a 3.5% decrease in sTNFrII at 30-min post exercise compared with baseline and a 49% decrease in GH at 60-min post exercise The CON group had a decrease in GH at 30-min (62%), and at 60-min (61%) post exercise compared with baseline.	GH increase from baseline to post was greater in the MOD group and a decrease in CORT from pre to post was greater than in the other groups.
Yarasheski at al. (2011)	Metabolic, endocrine, anthropomorphic, and safety parameters i.e. Insulin sensitivity (hyperinsulinemic glycemic clamp), metabolic, endocrine, glucose (hyperinsulinemic euglycemic clamp) anthropomorphic, central adiposity (DEXA), visceral adiposity volume, liver lipid content, safety parameters.	Improved peripheral Insulin sensitivity, decreased total body and limp adipose, decreased liver lipid content, fasting LDL and HDL-C concentrations were not changed	There were differences in response to the study protocol for males and female subjects.
Balasubramanyam et al. (2011)	Fasting triglycerides (automated analyzer), HDL-C, non HDL-C, plasma glucose (glucose oxidase method), insulin sensitivity (RIA), CD4 count (flow cytometry), HIV-1 vital load (quantitative PCR) glycemia, adiponectin (RIA), C-reactive protein, energy expenditure, hsCRP (latex particle-enhanced immunoturbidimetric and BC (BMI), FFA (microtiter procedure).	Fenofibrate improved triglycerides, TC and non-HDL-C. Niacin improved HDL-C. D/E + Fenofibrate + Niacin reduced triglycerides (-52%), increased HDL-C (+12%) and decreased non-HDL-C (-18.5%) and TC to HDL-C ratio (-24.5%). Niacin doubled adiponectin levels.	Combination therapy D/E + Fenofibrate + Niacin in group 5 was the most effective in lowering triglycerides, lowest ratio of cholesterol to HDL-C

REF	Study Variables	Results	Differences among study groups
Mendes et al. (2013)	Anthropometric, strength and cardiorespiratory fitness i.e. body perimeters (non-elastic measuring tape) (Sanny®), on neck, thorax, waist, hip, arm forearm, thigh and calf perimeters, Waist measurement, waist/hip ratio (WHR), body mass and stature using mechanical scale attached to stadiometer (Filizola®), body mass index (BMI), Skinfolds by a scientific adipometer brand name Lange® on tricipital (TR), bicipital (BI), subscapular, suprailiac (SI), chest (C), abdominal(AB), midaxillary (MA), thigh (T) and midcalf (MC). Arm muscle area, BFD, BF estimation, Strength test (1RM)on squat, bench press, hamstrings extension, triceps, back pulley, knee flexion and barbell curl, Cardiorespiratory fitness test measured by the modified multi-stage fitness test.	Body circumferences and waist-to-hip ratio changed after 24 weeks of REAC in both exercised groups. The sum of seven skinfolds, %BF, body fat mass, total fat, central fat and peripheral subcutaneous fat reduced in response to REAC. Lean body mass increased in exercised groups, regardless of the outcome (LIP or NoLIP). Strength and cardiorespiratory fitness increased in both exercised groups in response to REAC.	Reduction in the neck, thorax and waist perimeters and increase in the arm, forearm and calf perimeters have been observed in the EX groups. The waist perimeter and the WHR increased and the arm, forearm and calf perimeters reduced only in the NoEX+LIP group after the intervention. The Σ7 SF, %F and FBM increased in the NoEX+LIP and NoEX+NoLIP groups
Cade et al. (2013)	Basal myocardial insulin sensitivity and diastolic function. Fat and fat-free mass (DXA), Abdominal subcutaneous (SAT) and visceral adipose tissue (AIDS) (1H-magnetic resonance imaging), arterialized venous blood sampling(tomography), BP and HR, echocardiographic examination, Plasma glucose concentration (automated glucose analyser), Plasma insulin (chemiluminescent immunometric method), Peripheral insulin resistance (homeostatic model assessment), Fasting plasma lipid/lipoproteins.	In PIO - No significant changes in CD4+ T-cell count or plasma viral load, on whole-BF or fat-free mass or visceral or subcutaneous adipose tissue. Fasting plasma glucose and insulin levels trended lower after PIO, while peripheral metabolic parameters were unchanged. Myocardial oxygen consumption decreased slightly but not significantly. Basal myocardial insulin sensitivity did not change in response to PIO. Myocardial fatty acid oxidation and utilization rates increased slightly, but not significantly, resting systolic and diastolic function were unchanged. EXS- Whole-body peak oxygen consumption increased but not significantly, Visceral adipose tissue, fat-free mass, total fat mass, and subcutaneous fat content were unchanged, small improvements in fasting plasma glucose, insulin, triglycerides, and total and low-density lipoprotein. Basal myocardial insulin sensitivity non significantly increased. Myocardial fatty acid oxidation and utilization rates increased but not significantly, resting systolic and diastolic function were unchanged	Neither PIO nor EXS resulted in a detectable improvement in basal myocardial insulin sensitivity or diastolic function.

REF	Study Variables	Results	Differences among study groups
Troseid et al. (2014)	BF composition was measured by dual-energy x-ray absorptiometry scan, insulin-mediated glucose uptake was measured by euglycemic hyperinsulinemic clamp combined with stable isotope infusion, and lipopolysaccharide (LPS) was measured with the limulus amebocyte lysate assay	At baseline, the strength and endurance group did not differ significantly in CD4+ T-cell count, ART duration (10.3 vs. 9.0 years), body mass index (23.4 vs. 24.0 kg/m^2), fasting glucose (5.5 vs. 5.4 mmol/L), triglycerides (2.6 vs. 2.3 mmol/L), or trunk fat mass. lipopolysaccharide (LPS) levels were not significantly changed in the strength training group [6.8% reduction (20% reduction to 6.4%increase) both training modalities increased insulin-mediated glucose uptake, whereas strength training, but not endurance training, reduced triglyceride levels and trunk fat mass, reduced trunk fat, triglycerides, and improved insulin sensitivity after strength training were associated with reduced LPS levels, possibly mediated through a reduction in triglycerides.	There were no significant associations between changes in insulin-mediated glucose uptake, trunk fat, and LPS levels in endurance group.

3.4.2.4. ANTIRETROVIRAL THERAPY DURATION AND RESPONSE TO RESISTANCE EXERCISE INTERVENTIONS

Only one study by Mendes et al. (2013) subtly indicated ART duration background of participants in relation to RE intervention response. Mendes et al. (2013), considered participants who were on ART for at least one year and found that body circumferences, sum of seven skinfolds, percentage body fat, total fat, central fat and peripheral subcutaneous fat had reduced following RE and aerobic conditioning. Further, lean body mass increased in exercised groups, while strength and cardiorespiratory fitness increased in both exercised groups in response to RE and aerobic conditioning. The other studies did not indicate any association between participants' duration on ART and their response to RE interventions. Therefore, findings related to RE exclusively are undetermined due to multi interventions.

3.4.2.5. GENDER EFFECT ON RESPONSE TO RESISTANCE EXERCISE INTERVENTIONS

In the four studies that had participants of mixed gender, none of the studies indicated any gender differences in response to RE interventions. According to a study by Cade et al. (2013), the PIO Group had 25% of the participants being females. In further confirming that no gender differences affected responses to RE interventions Cade et al. (2013) established that, neither pioglitazone nor exercising group resulted in a noticeable increase in basal myocardial insulin sensitivity or diastolic function following an intervention involving RE, aerobic exercise and pioglitazone ingestion. Therefore, the studies did not distinct anthropometric, strength, chronic or non-chronic responses in relation to gender or compared gender outcome differences among their group participants.

3.5. LIMITATIONS

An important limitation to the studies included in this review was that none of the studies focused on exclusive resistance exercise. All the studies involved RE in combination with either an aerobic, nutritional and or pharmacological co-intervention. These studies also involved participants not in African contexts or source limited settings like Sub-Saharan Africa (SSA). All the studies did not mention issues of medication adherence and particular type of ART drugs or line of ART that participants were receiving. This was not considered as a study factor relating to PLWHA's responses to RE interventions. The studies included for review did not observe similar prescriptions regarding optimum dose regarding the RE mode, intensity, frequency, rest and maximal study durations. The same inconsistency was noted in the aerobic exercise modes involved as co-interventions. The HIV-clinical stages of participants were not considered as a variable affecting response to RE interventions in PLWHA.

The specific types of resistance exercise or aerobic exercises (as co-intervention) were scarcely mentioned in some of the studies included in this review. It may also be likely that not all suitable papers were retrieved. Excluded or included keywords may have eliminated relevant papers not identified during searching of reference lists of retrieved studies.

3.6. CONCLUSIONS AND RECOMMENDATIONS

Resistance exercise interventions in combination with other components seem to improve body composition, chronic disease risk parameters, self-efficacy, bodily functioning, strength and psychologic conditions in PLWHA. Studies do not indicate much difference in responses to resistance exercise interventions between males and female. There are significant differences between exercising groups and none intervention CON groups.

The study findings assert that a potent remedy for PLWHA can exist in RE training. However, RE interventions are being used in combination with other co-interventions. The variations in study methodologies calls for unvarying and uniform co-intervention procedures, establishing maximum and minimum study duration, identifying specific types of RE or aerobic co-intervention and prescribing standard exercise doses in order to produce a clearly set of study criteria. Furthermore, there is generally no consensus on the type or types of co-interventions, their duration, design variation and outcome study variables.

It is highly recommended that exclusive RE interventions are safe and largely beneficial to PLWHA receiving ART. The exercise training modality may be adjusted to one’s level of ability (individual 1RM and symptomatology) and progressively increased. Resistance exercise training then tends to be safe for both male and female PLWHA on ART regardless of ethnic background, (Anderson, 2006). Resistance exercise intervention studies have been conducted more in developed nations than developing ones.

A period of 6-12 weeks on a RE or aerobic intervention training programme appears to improve body composition and strength of PLWHA is concerned. The RE intervention studies for PLWHA are mostly affected by challenges of adherence and drop out. The bottom line being that, exercise prescriptions should mirror standard protocols according to the American College of Sports Medicine which states that, frequency should be two to three days per week, eight to ten repetitions, targeting 10-12 muscle groups, two to three sets at 60-80% of individual’s 1RM (Pescatello et al., 2014:294).

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Author Contributions

VM wrote the manuscript. TS, was key to concept development, manuscript writing, editing and revising. All authors approved the final submission.

Conflicts of Interest

The authors declare no conflict of interest.

CHAPTER FOUR: ARTICLE II- MANUSCRIPT

The University of Kwa-Zulu Natal permits the dissertation to be presented in a manuscript format. The following manuscript will be submitted for publication.

EFFECTS OF A RESISTANCE EXERCISE INTERVENTION PROGRAMME ON BODY COMPOSITION, CHRONIC DISEASE RISKS AND STRENGTH SCORES IN PEOPLE LIVING WITH HIV/AIDS RECEIVING ANTIRETROVIRAL THERAPY, IN ZIMBABWE

Victor Mbayo [1], Takshita Sookan [1]

[1] Discipline of Biokinetics, Exercise and Leisure Sciences, School of Health Sciences, University of KwaZulu-Natal.

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4.1. ABSTRACT

In Zimbabwe, Human Immunodeficiency Virus (HIV) mortality rates have continued on an upward trend. The number of those starting antiretroviral therapy (ART) each year has also increased. Generally, the commencement of ART, coupled with nutritional interventions, in PLWHA has increased their life expectancy. In the long term PLWHA are now living longer to the extent that they develop lifestyle conditions like hyperlipidaemia, obesity, diabetes mellitus and hypertension, among other chronic disease risks. This has led to a reduction in their general physical fitness levels and strength. Resistance exercise (RE) can be beneficial to PLWHA in alleviating these chronic disease risks. However, there is little information and limited inclusion of RE programmes as healthy lifestyle intervention for PLWHA receiving ART in Zimbabwe.

4.1.1. AIMS

The purpose of this study was to investigate the effect of a RE intervention programme on body composition, chronic disease risks and strength in PLWHA receiving ART.

4.1.2. METHODOLOGY

This was a 12 week experimental, pre-test, post-test study measuring somatic and biologic markers in 128 PLWHA on an outpatient basis. The participants were from Budiriro and Mabvuku communities that work with the Zimbabwe National Network for people living with HIV/AIDS (ZNNP+) a local Non-Governmental organisation in Harare. The participants from Budiriro were randomly allocated to an experiment group i.e. the EXP group (n=64) while those in Mabvuku to a control group i.e. the CON group (n=64). The EXP group (n=64) had a mean age of 39.16 ± 4.708 years, height 1.69 ± 7.47 m and weight 68 ± 15.9 kg participated in a 12 week RE intervention programme attending sessions three days a week. The CON group (n=64) had a mean age of 39.31 ± 4.382 years, height 1.641 ± 8.90 m and weight 65.9 ± 8.14 kg and did not participate in the RE intervention programme and were prescribed exercise after the 12 weeks for ethical reasons only. Body composition (body mass index, waist hip ratio, percentage body fat, fat mass, lean body mass), chronic disease risks (fasting blood glucose, fasting total blood cholesterol, blood pressure) and one-repetition maximum (1RM) strength tests were pre-and post-measured in all participants. The study variables were analysed using ANCOVA to compare each study variable between the EXP group (n=64) and the CON group (n=64) allowing for (correcting for) variability of other covariates. SPSS statistical package version 22 was used and significance set at $p \leq 0.05$.

4.1.3. RESULTS

The post-test body composition, fasting blood glucose and fasting total blood cholesterol scores remained high in the CON group (n=64) and improved significantly ($p<.0005$) in the EXP group (n=64). At post-test, 100% of participants in the CON group (n=64) were still pre-hypertensive while 66% of the EXP group (n=64) participants had improved from hypertension stage 2 to hypertension stage 1. Strength (1RM) levels in the EXP group (n=64) increased significantly ($p<.0005$) for the bench press, squat, bicep curl and leg curl than in the CON group (n=64).

4.1.4. CONCLUSION

Resistance exercise are safe and beneficial for PLWHA in resource constrained settings. Body composition, chronic disease risks and strength can be positively addressed using RE in PLWHA.

4.1. INTRODUCTION

Antiretroviral therapy (ART) involves an assortment of drugs to suppress growth of the HIV virus (AIDSinfo, 2016). It is strongly recommended that ART be initiated in all adults with HIV regardless of the World Health Organisation (WHO) clinical stage and at any CD4 cell count, to reduce the morbidity and deaths associated with HIV infection (AIDSinfo, 2016; World Health Organisation, 2015). With treatment, the life expectancy of PLWHA receiving ART improves (Ciccolo et al., 2014). However, studies show that PLWHA although they now live longer, western diets and sedentary lifestyles are predisposing them to chronic disease risks or non-communicable diseases (NCDs) (Grochocinski, 2011). Non-communicable diseases have become the leading cause of non–HIV-related deaths among PLWHA (Post, 2012). The prevalence of chronic disease risks especially cardiovascular diseases (CVDs) in PLWHA is now similar to the uninfected population with developing nations, particularly in Africa, being greatly affected (Jerico et al., 2005; Stein, 2010).

Hyperlipidemia, fat redistribution (lipodystrophy), peripheral neuropathy, decreasing bone mineral density, high blood pressure, strokes, overweight and obesity are among a host of chronic disease risks affecting PLWHA receiving ART. High blood glucose levels leading to type 2 diabetes mellitus also affect PLWHA following ART initiation (Crane et al., 2006; Denue et al., 2013; Grinspoon and Carr, 2005 ; Grochocinski, 2011; Nemaura et al., 2013; Neto et al., 2013; Teklay et al., 2013). Each antiretroviral drug class causes different chronic disease risks in PLWHA (AIDSinfo, 2016). The chronic disease risks affect both men and women, although females, with a high body mass index, of black African ethnicity and older males on treatment for more than ten years are affected more (Akl et al., 2017; Boccara et al., 2013; Cerrato et al., 2015; Domo and Jalyson, 2015; Guehi et al., 2016; Hubbard, 2007; Malapati et al., 2014; Palacios et al., 2006; Triant, 2014).

Pharmacological lipid-lowering agents including hormones (Stanley and Grinspoon, 2012), alendronate and vitamin D (McComsey et al., 2010), surgery (Hubbard, 2007), nutritional supplementation (Mudzviti et al., 2012) and insulin sensitising agents (Grinspoon and Carr, 2005) all appear to be effective in combating chronic disease risks. Lifestyle interventions involving changes in alcohol consumption, tobacco smoking, diet and engaging in exercise are highly recommended for PLWHA receiving ART (Compston, 2015; McComsey et.al, 2010).

Studies show that, RE stimulate muscle building, reduce fat build-up and improve overall health, thereby enhancing a sense of well-being in the PLWHA (Gomes Neto et al., 2015; Hamid and Rajah, 2015; Hunter et al., 2010; Lands, 2015; Malita et al., 2005; Mutimura et al., 2008; Paes et al., 2014; ACSM, 2014, p.293; Souza et al., 2011).

Resistance exercise are an effective natural means of addressing identifiable chronic disease risks in PLWHA (Bonjoch et al., 2010; Malita et al., 2005; Roubenoff and Wilson, 2001; Srikanthan and Karlamangla, 2014). According to Yarasheski et al. (2001) RE improve strength, lean mass, trunk adipose mass and thigh muscle circumference scores in PLWHA. Other studies involving RE noted similar findings following their investigations (Hamid and Rajah, 2015; Souza et al., 2011). In Zimbabwe, Mkandla et al. (2016) conducted the only hospital-based study to establish the effect of a RE intervention programme on the health-related quality of life in those living with HIV-related distal symmetrical poly-neuropathy. The resistance exercise intervention considerably improved health-related quality of life in the PLWHA as compared to the CON group.

Over half a million people receive ART, and thousands more commence treatment daily in Zimbabwe, (UNAIDS, 2015). It was established that, this same population now record increased incidences of overweight and obesity (Takarinda et al., 2017), high blood pressure (Mutede et al., 2015).

Zhou et al. (2016) identified this epidemiological development as an increased incidence of chronic disease risks among PLWHA receiving ART in Zimbabwe. Mutede et al. (2015) then suggested possible lifestyle changes including exercise. However, there is still limited data on the adoption of RE as a lifestyle intervention for PLWHA in the country (Quiles and Ortiz, 2017). Therefore, the present study aim was to investigate the effect of a RE intervention programme on body composition, chronic disease risks and strength in PLWHA receiving ART in Zimbabwe.

4.2. METHODS

All procedures were each carried out at the two Community Centres in Harare following ethical approval from the Medical Research Council of Zimbabwe (MRCZ) and the University of Kwa-Zulu Natal-Biomedical Research Ethics Committee (BREC); REF: MRCZ/B/948 and BF293/15, respectively (Appendix A and B). The clearances from gatekeepers were also obtained from the Ministry of Health and Child Care (MoHCC) in Zimbabwe (Appendix C), the National AIDS Council, Harare (Appendix D), the ZNNP+ (Appendix E) and the District Community Council (Appendix F).

4.2.1. STUDY DESIGN AND PARTICIPANT RECRUITMENT

This was an experimental, pre-and post-test study. A total of 128 sedentary male and female PLWHA, receiving ART on an outpatient basis, aged between 18 and 45 and of black African ethnicity, from Mabvuku and Budiriro in Harare, were screened based on medical doctor's approval to participate in this study. Following initial baseline assessments the participants in Budiriro were randomly allocated as the EXP group (n=64) and those in Mabvuku allocated to the CON group (n=64). The EXP group (n=64) was taught and trained weight training before being required to perform RE using body and free weight gym equipment. The resistance exercise intervention programme targeted intensity ranging from 50% of each individual's 1RM initially and progressively reaching 80% during the final week (for squats, bench presses, leg curls and bicep curls). The EXP group (n=64) participants completed two to three sets, of eight to ten repetitions, three times per week over 12 weeks. The CON group (n=64) did not partake in any exercise programme during the 12 week study period and were prescribed exercise thereafter following the same protocol for ethical reasons. The exercise sessions were supervised and monitored by four research assistants at Mabvuku and Budiriro community fitness centres.

4.2.2. PARTCIPANTS CHARACTERISTICS

The criteria for participants to be recruited into this study included having CD4 counts of $\geq$350 cells/mm^3, an absence of opportunistic infection and no pre-existing participation in an exercise programme. Pre-menopausal female subjects were not pregnant or lactating, had had regular menstrual cycles for the past year and had been medically diagnosed as HIV-infected. The exclusion criteria included individuals with Acquired Immune Deficiency Syndrome; musculoskeletal disorders; seriously ill and bed-ridden individuals; being HIV negative; any history of leg injury and back pain; congestive heart failure; angina, cardiovascular and peripheral vascular diseases. Individuals who had experienced a cold or fever at least one month leading up to the protocol, those with flu symptoms or of non-black African ethnicity were excluded. Also excluded were individuals taking medication that affected central or peripheral circulation. Those on nonsteroidal anti-inflammatory agents or serotonin reuptake inhibitors; who engaged in an existing exercise programme and having any other medical condition that could be exacerbated by lifting weights were also excluded.

Every participant was informed of all investigational procedures, including the risks and benefits associated with participation in the study before providing a signed informed consent form, prior to participation in the study.

4.2.3. EXPERIMENTAL PROTOCOL

4.2.4. SESSION 1: SCREENING

The study included pre-test initial screening of participants, after which they were randomly allocated to the two groups. Participants were each assigned a numerical identification code number to ensure privacy. Prior to participation in the study participants were provided with information regarding the study (Appendix G) and completed a written informed consent form (Appendix H). The initial visit consisted of screening participants using the medical doctor's note and further considering responses provided on completed full health history form and International Physical Activity Readiness Questionnaire (IPAR-Q) to ensure that they met the inclusion criteria in consultation with the medical doctor. The participants were informed of their qualification for selection and given the next appointment time to visit the Community Fitness Centre for consecutive study sessions to conduct pre-test, RE intervention and post-test procedures.

4.2.4.1. THE QUESTIONNAIRE

The nutritional risk assessment questionnaire was developed Medical Nutrition Therapy Associates and is intended to identify non-pregnant, non-lactating clients at risk for calories, vitamin, mineral and fiber deficiency; excess sodium, fat and sugar intake; problematic weight control behaviours or attitudes. The questionnaire was further validated by the Ministry of Health and Child Care in Zimbabwe **(**MoHCC) (Appendix C). The Participants completed the five part questionnaire with reference to their demographics, IPAR-Q, exercise adherence, health risk background and nutritional risk (Appendix I). The participants were assisted in responding to the self-administered questionnaire and vernacular explanations were given in areas they did not understand fully.

a. **Demographic Information**

The demographic information section of the questionnaire sought participants' gender, age, level of education and marital status.

b. **International Physical Activity Readiness Questionnaire (IPAR-Q)**

IPAR-Q is an internationally approved pre-participation health risk appraisal for individuals about to begin a physical fitness activity programme, designed by the American Heart Association and American College of Sport Medicine (ACSM, 2014, p.23). The IPAR-Q allowed participants to give YES or NO responses. This section of the questionnaire also established exercise backgrounds and the weekly exercise habits (type and duration) of participants.

c. **Health Risk**

The health background risk segment of the questionnaire required participants to respond to questions regarding their cardiovascular risk factors. It also required participants to provide information on the estimated time since each had been diagnosed HIV-positive, and the ART they were receiving, on an outpatient basis.

d. **Nutritional Risk**

Participants rated their dietary intake for a week, including breakfast; lunch; dinner; herbal supplements; protein powders; eating out at restaurants; and whether they were on a special diets for medical reasons. The participants provided information on portion sizes for each food item, and according to ‘servings per day, per week, per month or never ate’. This was in reference to five food groups: group one was bread, cereal, rice and pasta; group two was fruit and vegetables; group three included milk, yogurt, and cheese; group four was meat, poultry, fish, dry beans, eggs, and nuts; and group five included fats, oils, and sweets.

e. **Body image**

The concluding segment of the questionnaire required participants to respond with YES or NO to questions about body image, eating disorders and weight management.

4.2.5. SESSION 2: BASELINE LABORATORY TESTING

The baseline testing session took place a week before participants took part in the study protocol at the community centres in Mabvuku and Budiriro. On arrival participants were familiarised with the laboratory testing procedures and the necessary baseline measurements. The measurements were taken observing issues of privacy and confidentiality hence each participant was measured by a research assistant of the same gender in designated testing rooms for males and for females. Ethical principles followed were respect for persons, beneficence (doing good) and justice. Participants were also identified by their code numbers for privacy. Testing rooms were made as comfortable as possible at room temperature with chairs, tables and curtains. World Health Organisation guidelines on drawing blood, best practices in phlebotomy and clinical health standards were followed and among others included safety handling of consumables including lancets, wearing of latex gloves by the testing research team members and disposal of used alcohol swabs. The research team also included medical personnel cleared by the Medical Research Council of Zimbabwe for this study. The used lancets, cotton balls, gauzes and latex gloves were immediately disposed in a plastic sharps bin and send for incineration at the end of each session. A first aider was in attendance during sessions.

Participants had been asked to fast before arriving, to measure their fasting blood glucose and fasting total blood cholesterol. The pre-test session also involved measuring blood pressure, anthropometrics (weight and height), waist and hip circumferences and body composition using skinfolds. The visits were all scheduled during morning hours in order to control the study variables.

4.2.5.1. ANTHROPOMETRIC MEASUREMENTS

Standing height (stature), mass and waist and hip (girths) circumferences were the anthropometric variables measured, observing International Society for the Advancement of Kinanthropometry standards (ISAK, 2001:7).

a. Height

The SECA stadiometer were used to measure height. The participants had their height measured without wearing any head gear or footwear. Participants stood with heels, buttocks and upper part of the back touching the wall. The head was placed in the Frankfort plane. Participants would take and hold a deep breath, while keeping the head in the Frankfort plane, with one research assistant applying firm upward lift through the mastoid processes. The recorder placed the head board firmly down on the vertex, crushing the participant’s hair as much as possible to take a reading. The recorder further assisted by watching that the feet of each participant did not lift off the floor and that the position of the head was being maintained in the Frankfort plane. Measurements were taken at the end of a deep inward breath and the reading was then taken to the nearest 0.1 cm (ISAK, 2001:7). The participants had repeat measurements of their height three times and an average determined as the final height. See the anthropometrics recording sheet in (Appendix J).

b. Weight

Weight was measured using a SECA electronic scale (SECA Deutschland Medical Scales and Measuring Systems, Hamburg, Germany). The measurements were taken on participants while barefooted and with minimal clothing. Excess accessories were also removed. The scale was checked to make sure it was reading zero. The participants stood on the middle of the scale without support and with the weight distributed evenly on both feet. The SECA electronic scale measuring to the nearest 50g was used. The participants had repeat measurements of their weight three times and an average determined as the final weight (ISAK, 2001:8).

c. Waist-Hip Circumferences

A Lufkin W606PM 2m flexible steel tape measure, with automatic retraction, calibrated in centimetres by millimetre gradations was used to measure circumferences.

4.2.5.1.1. Waist measurement

Participants assumed a relaxed standing position with the arms folded across the thorax. The waist (girth) circumference was measured at the level of the narrowest point between the lower costal (10^{th} rib) border and the iliac crest. The participants' abducted their arms slightly allowing the tape to be passed around the abdomen in front and the tape adjudged to the level of the narrowest point. The participants were instructed to lower their arms to the relaxed position. The tape was then readjusted as necessary to ensure it did not slip or excessively indent the skin. Each participant was allowed to breathe ordinarily and the measurement was taken for recording (ISAK, 2001:83). When reading the tape the eyes were at the same level as the tape for accuracy to the nearest millimeter. Repeat measures were three per each participant and an average calculated for recording.

4.2.5.1.2. Hip measurement

The hip (gluteal) girth was measured at the level of the greatest posterior protuberance of the buttocks which usually corresponds anteriorly to about the level of the symphysis pubis. The research assistant passed the tape around the hips from the side. The tape adjusted to the level of the greatest protuberance of the buttocks. The participants assumed a relaxed upright position with the arms folded across the thorax. The participants were instructed to place feet together and to relax the gluteal muscles. The tape was then readjusted as necessary to ensure it did not slip or excessively indent the skin. Then using the cross-hand technique, the tape was held in front and on the sides so that it was held in a horizontal plane at the target level.The tape was passed around the hips from the side and a measurement was taken for recording (ISAK, 2001:84). When reading the tape the eyes were at the same level as the tape for accuracy to the nearest millimeter. Repeat measures were three per each participant and an average calculated for recording.

4.2.5.2. BODY COMPOSITION MEASUREMENTS

a. Skinfolds

A Slim Guide skinfold calliper was used to take the skinfolds. Skinfold measurement is a field procedure to determine body composition levels, since the amount of subcutaneous fat is proportional to the amount of body fat (ACSM, 2014:67). The measurements were taken with participants wearing minimal clothing. Measurements were taken observing International Society for the (ISAK, 2001:63-71). The participants assumed a relaxed upright position with arms on the side. The research assistant then identified seven skinfold locations and marked the skin with a pen for all skinfold landmarks.

At the marked skinfold, the research assistant lightly tweaked and lifted the skin until a double fold of skin formed, including the underlying subcutaneous adipose tissue, which was held between the thumb and index finger of the research assistant's left hand.

The near brink of the thumb and finger were in line with the marked site. The nearest edge of the contact faces of the calliper was applied about one centimetre away from the edge of the thumb and finger. The calliper was held at 90° to the surface of the skinfold site at all times and a measurement was recorded two seconds after the full pressure of the calliper was applied. The seven skinfold sites measured on each participant were the triceps, chest, abdominal, subscapular, suprailiac, mid-axilla and front thigh (ISAK, 2001:63-71).

The skinfold site scores enabled participants' body compositions to be calculated. Three repeat measures were taken and an average recorded. The skinfold measurements were recorded in Appendix J. In all participants, Jackson and Pollock's equation (ACSM, 2014:69)for men and women (seven skinfold sites) was used to determine body density, after which percentage body fat was calculated using the Siri Equation:

$$\% \text{ Body Fat} = (495 / \text{Body Density}) - 450$$

4.2.5.3. CHRONIC DISEASE RISK MEASUREMENTS

a. Blood Pressure

Blood pressure was measured using the HI-CARE deluxe stethoscope Rappaport type and HI-CARE sphygmomanometer. The rooms set aside at the fitness community centres were used to measure blood pressure of participants. The participants were seated with the arm flexed at the elbow at the level of the heart. The properly sized cuff was wrapped around the upper arm, while the stethoscope's bell was pressed over the brachial artery just below the cuff's edge. The cuff was rapidly inflated and then air was released from the cuff at a moderate rate (3mm/sec). The recorder simultaneously listened to the heartbeat with the stethoscope and observed the reading on the sphygmomanometer. Both systolic pressure and diastolic pressure were recorded (ACSM, 2014:45).

Blood pressure scores were classified according to the new American Heart Association and American College of Cardiology guidelines (AHA/ACC, 2017). The categories of blood pressure were recognised as follows: normal <120/80 mmHg; elevated 120-129/80 mmHg; hypertension (stage 1) 130-139/80-89 mmHg; hypertension (stage 2) ≥140/ ≥90 mmHg. See Appendix K for chronic disease risks recording sheet.

b. Fasting Blood Glucose

Blood glucose was measured using an Accutrend Plus digital meter, Roche, Mannheim, Germany. Fasting blood glucose levels were measured. The research assistant first put on latex gloves after checking the functionality of the meter. The meter was then switched on and coded with a coding strip inserted into the meter. The participant's hands were washed and after drying, the preferred fingertip of the participant was wiped with an alcohol swab. A test strip was inserted into the blood glucose meter.

The preferred finger of the participant was pricked and a drop of blood was put on the test strip and then the reading was taken after 12 seconds. Test results were displayed on the monitor's screen after a beep and results were recorded. The used test strip was removed to reset the monitor. The pricked fingertip was then dressed with a gauze pad or Elastoplast bandage. The cotton swab, test strip and used lancet were discarded properly after use. Fasting blood glucose levels were categorised as follows: normal glucose tolerance 3.9-5.5 mmol/L; impaired fasting blood glucose (pre-diabetes) 5.6- 6.9 mmol/L; and very high blood glucose (type 2 diabetes) >7 mmol/L (ACSM, 2014, p.279).

c. **Fasting Total Blood Cholesterol**

Fasting total blood cholesterol was measured using an Accutrend Plus digital meter, Roche, Mannheim, Germany. The research assistant wore latex gloves. The participant's initially lanced finger was again squeezed gently to draw another drop of blood. A second lancing was done only when necessary. The test strip was inserted into the meter and the reading was taken after 180 seconds. Test results were displayed on the monitor screen after a beep and results recorded. The used test strips were removed to reset the monitor and the pricked fingertip was then dressed with a gauze pad or Elastoplast bandage. Fasting total blood cholesterol scores are classified as: desirable <5.1 mmol/L; borderline high, 5.1-6.1 mmol/L and very high >6.2 (ACSM, 2014, p.46).

4.2.6. SESSION 3: BASELINE STRENGTH TESTING

The baseline strength testing session took place in the gym at the community fitness centres (in Mabvuku and Budiriro) two weeks before participants took part in the study protocol and involved determining their 1RM.

4.2.6.1. ONE-REPETITION MAXIMUM (1RM) TEST

The baseline strength levels of all participants were determined using 1RM tests (for bench press, squat, bicep curl and leg curl). All participants were led through a warm up, performing submaximal repetitions of the specific exercises according to ACSM (2014, p.96). The rest observed between each 1RM test procedure was 48 hours. The 1RM was determined within four lifts, observing three to five minute rests, assisted by a spotter. Normative data for predicting 1RM was used to select weights that were within the perceived capacity of each participant (i.e.50-70% 1RM). Weights of 2.5 to 20 kg were progressively added until a complete repetition could no longer be performed. Then, the previous weight lifted successfully become the 1RM for that exercise. The lifted 1RM values for each exercise were recorded (Appendix L) and test results were used to design the RE intervention programmes for the EXP group (n=64) participants. Therefore, these results gave a clear-cut indication of how much weight each participant was able to lift, one repetition across a number of exercises that were included in this study. A cool down activity was done at the end of each session participants. Any participant showing great discomfort during this procedure were stopped and rested. Again participants were encouraged to remain hydrated and avoid the Valsalva manoeuvre (forceful attempted breathing out against a closed airway). Once baseline strength had been established, participants took part in a body weight strength conditioning programme (circuit) for four days a week before the study began. Two more days were set aside to familiarise participants with weight training, equipment, breathing technique, hydration, maintaining a high calorie diet, gym etiquette, and health and hygiene rules in gyms.

4.2.6.2. BODY WEIGHT STRENGTH CONDITIONING PROGRAMME

Table ix: Body weight strength conditioning programme

DAY	ACTIVITY	REPS	REST BETWEEN STATIONS(mins)	SETS	REST AFTER A COMPLETE SET(mins)
1 and 2	Warm up : Jogging (200m)	4	1	2	3
	Dynamic Stretches Over (10 metres) Butt kicks High knees Pulling down mangoes Ankling Bounding Hopping Combinations	3	10	2	3-4
	Body weight Press-ups Squats Sit ups Leg raises Calf raises Burpees	8-10	2-3	3	4-5
	Cool down Static stretches Breathing exercises				
DAY	ACTIVITY	REPS	REST BETWEEN STATIONS	SETS	REST AFTER A COMPLETE SET
3 and 4	Warm up: Jogging (200m)	4	1	2	2
	Dynamic Stretches Over (10 metres) Butt kicks High knees Pulling down mangoes Ankling Bounding Hopping Combinations	6	1	2	3
	Body weight Press-ups Squats Sit ups Leg raises Calf raises Burpees	10-12	2	3	4-5
	Cool down Static stretches Breathing exercises				

4.2.7. SESSION 4: RESISTANCE EXERCISE INTERVENTION PROTOCOL

In the study, participants took part in a supervised RE intervention programme, following American College of Sports Medicine (ACSM) protocols for PLWHA, ACSM (2014, p.294). The RE programme was undertaken in the gym at Budiriro community fitness centre. The EXP group (n=64) participants performed the RE programme based on each individuals' pre-test 1RM, obtained during session 3, for bench press, squat, bicep curl and leg curl. The RE programme was carried out three days a week (Mondays, Wednesdays and Fridays) for 12 weeks. The exercise sessions involved working biceps, triceps, chest, hamstrings, quadriceps and calf major muscles. Participants were encouraged to maintain a calorie diet, rehydrated avoiding the Valsalva manoeuvre. The participants were put into five groups and each group was monitored and supervised by a research assistant who also worked as a spotter. The groups followed a circuit training format to work out at each station. Body weight exercises were performed on Wednesdays only during the first four weeks. The free weight and gym equipment exercises performed included preacher curls (using barbell with weights on a bicep bench), triceps extensions (triceps extension machine), bench presses (using a barbell with weights on a weight bench), leg curls (using a leg curl machine), squats (using barbell with weights on a squat rack) and calf raises (using barbell with weights). In each session, the EXP group (n=64) participants embarked on a 10-20 minute warm-up involving light jogging, stretches, light weight exercises; and ended with an eight to ten minutes cool-down and overall duration took up to 2 hours per day. Each participant performed five sets of exercises in a circuit format. The EXP group (n=64) participants were encouraged to continue training since the RE benefits were already noted. The exercise workout recording sheet is in Appendix M. The following table illustrates the protocol:

Table x: Resistance exercise intervention procedure

Week	Load as % of individual 1RM	No of repetitions per exercise	Volume (no. of sets)	Rest after each set of 10 (in minutes)	Time to complete (in minutes)	Type of Exercises
1-2	50	10	3	2	30	free weight
3-4	60	10	3	2	30	free weight
5-6	65	10	3	2	30-50	Free weight, gym equipment
7-8	70	8	2	3	30-50	Free weight, gym equipment
9-10	75	8	2	3	30-50	Free weight, gym equipment
11-12	80	8	2	3	30-50	Free weight, gym equipment

Adapted from (ACSM, 2014, p.294; Tiozzo et.al, 2013).

4.2.8. SESSION 5: POST-TEST MEASUREMENTS

The baseline anthropometric (height and weight) measurements for body composition (body mass index, waist hip circumferences, percentage body fat and lean body mass), chronic disease risks (fasting blood glucose, fasting total blood cholesterol) and strength (1RM), which had been taken at pre-test (prior to the study protocol), were measured once more at the post-test 12 week RE intervention programme, in all the participants. The measurements were taken at the same time of the day, in the morning, with fasting blood glucose and fasting total blood cholesterol measured after participants had fasted 6-12 hours. The results were then analysed to draw conclusions and present recommendations.

4.2.9. STATISTICAL ANALYSES

ANCOVA was used to compare one variable in the CON group (n=64) group and the EXP group (n=64) correcting for variability of other covariates. The dependent variable was the post-measure, the covariate was the pre-measure and the independent variable was the group. This was calculated to determine significant difference in the post scores for the two groups i.e. in the CON group (n=64) and the EXP group (n=64) after correcting for the pre-scores.

Variables on which ANCOVA was used include blood cholesterol, blood glucose, body composition (body mass index, percentage body fat, lean body mass, waist-hip-ratio, body weight) and strength. It was also used to determine effect of gender on study variables in finding out suitability or note differences in response rates on male and female participants following RE.

Means and standard deviations as descriptive statistics were used with frequencies represented in tables and graphs. Descriptive statistics were used to analyse food group intake for it was tested at one time and not pre and post. If conditions did not allow the Chi-square test of independence was used to determine whether a significant relationship existed between two categorical variables represented in cross tabulation.

Chi-square was used to analyse Blood pressure because it was categorical hence it would allow for analysing if there was a relationship between pre- and-post blood pressure classifications. Chi-square was also used on cross tabulations of food group intakes to see if there were any relationships between dietary intake and group.

When conditions were still not met Fisher's exact test taking into consideration the small sample size. Therefore, Fisher's exact test was also used on cross tabulations of food group intakes to see if there were any relationships between dietary intake and group. Linear regression analysis was conducted to estimate the coefficients of the linear equation, involving one or more independent variables that best predict the value of the dependent variable. Food group intakes and blood pressure were analysed using linear association.

Binomial tests were used to test whether a significant proportion of the respondents selected one of a possible number of responses that showed significant effects. Body image was analysed using Binomial test to find out if a significant proportion answered 5 or more "YES" responses to indicate an eating disorder. This was then extended when data with more than two response options needed to be split into two groups.

Pearson's and Spearman's correlation were used to test if scale or ordinal variables were linearly related. Pearson's correlation (a measure of linear association) was used to test for correlation between study variables while Spearman's correlation analysed blood pressure classification since blood pressure was ordinal and not continuous.

Significance was set at $p \leq 0.05$ and the SPSS statistical package 22 was used to carry out the analysis.

4.3. RESULTS

4.3.1. DEMOGRAPHIC CHARACTERISTICS

After screening, the EXP group (n=64) and the CON group (n=64) participants showed the following characteristics in Table XI, below. No significant differences (NS) were noted in age, gender, education, marital status and physical activity readiness among participants.

Table xi: Participant's baseline characteristics in the EXP group (n=64) and the CON group (n=64)

(p-value = NS)			
Characteristic	EXP (n=64)	CON (n=64)	Total Av (n = 128)
Age (years)	39.16 (±4.708)	39.31 (±4.382)	39.24 (±4.545)
Males (%)	28.1	14.1	21.1
Females (%)	71.9	85.9	78.9
Weight (kg)	68.03 (±15.938)	65.97 (±8.142)	67(±12.04)
Height (cm)	169.95 (±7,479)	164.15 (±8.907)	167.05(±8.19)
Body mass index (kg/m^2)	23.64 (±5.722)	24.62 (±3.583)	24.13(±4.65)
% Body fat (%)	21.26 (±10.017)	22.62 (±6.636)	21.94(±8.32)
Fat mass (kg)	15.67 (±10.213)	15.10 (±5.523)	15.385(±7.87)
Lean body mass (kg)	52.42 (±8.360)	50.87 (±6.340)	51.65(±7.35)
Waist circumference (cm)	84.34 (±11.551)	77.90 (±13.586)	81.12(±12.57)
Hip circumference (cm)	99.00 (±13.946)	94.56 (±16.112)	96.78(±15.09)
Education			
Primary (%)	34.4	37.5	35.9
Secondary (%)	62.5	54.7	58.6
Tertiary (%)	3.1	7.8	5.5
Marital Status			
Single (%)	14.1	25.0	19.5
Married (%)	43.8	42.2	43.0
Separated/Divorced (%)	34.4	23.4	28.9
Widowed (%)	7.8	9.4	8.6
IPAR-Q			
Needing Clearance (%)	10.9	42.2	26.6
Ready (%)	89.1	57.8	73.4

The mean age of all participants was 39.24 ± 4.545 years. In the 128 total participants, 78.9% were females, and 21.1% were males. In total, 5.5% of participants had tertiary level education; in comparison to the 35.9% who had completed primary school, and the 58.6% with secondary level education. A relatively large percentage of participants were married (43%), while a combined 48.4% were single, divorced or separated. Only 8.6% were recorded as widowed. In the EXP group (n=64), 10.9% and in the CON group (n=64) 42.2% required medical clearance prior to the study since all participants had to have their strength (1RM) levels measured initially.

4.3.2. PARTICIPANTS EXERCISE BACKGROUND CHARACTERISTICS

The exercise backgrounds of participants showed that they were not taking part in any formal exercise programme prior to the study protocol. The Table XII shows the type of exercise, and the time and frequency of exercise, which participants were occasionally involved in before they participated in the study.

Table xii: Participants' exercise backgrounds in the EXP group (n=64) and the CON group (n=64)

(p-value = NS)			
PARAMETER (%)	EXP (n=64)	CON (n=64)	TOTAL Av (n=128)
Exercise Type			
Walking (%)	78.1	81.3	79.7
Jogging (%)	0.0	0.3	0.15
No exercise (%)	21.9	12.5	17.2
Time			
More than 1 hr/wk (%)	7.8	15.5	11.7
1 hr/wk (%)	50.0	39.1	44.5
Less than 30 mins/wk (%)	28.1	21.9	25.0
Nil/wk (%)	14.1	23.4	18.8
Frequency of Exercise			
More than 4 times/wk (%)	4.7	7.8	6.3
3-4 times/wk (%)	51.6	43.8	47.7
1-2 times/wk (%)	29.7	21.9	25.8
Nil times/wk (%)	14.1	26.6	20.3
Interest in Exercise			
NO (%)	3.1	3.1	3.1
YES (%)	96.9	96.9	96.9

There were no significant differences between the groups in exercise backgrounds. Across all the participants, (79.7%) were involved in walking, far exceeding the 0.15% jogging, and the 17.2% not exercising at all. Only 11.7% of all participants spent more than an hour per week exercising. Only 6.3% of participants exercised more than four times a week. Although 96.9% of participants expressed interest in exercising, they generally fell below the required 30 minutes of exercise on most days, as required according to the (ACSM, 2014:293). Not much difference in exercise backgrounds were noted among participants.

4.3.3. PARTICIPANTS MEDICATION AND HEALTH RISK BACKGROUND

There were more participants receiving first line ART medication than second line medication on an outpatient basis at 77.3% and 22.7%, respectively. There was little difference in the length of time (average total mean years) since participants had been diagnosed HIV-positive 5.74 ± 3.751 years. Similarly, average total mean years of receiving ART medication among participants was also at 5.21 ± 3.417 years. The Table XIII shows the medication and health risk backgrounds of participants.

Table xiii: Medication and health risk backgrounds in the EXP group (n=64) and the CON (n=64)

	(p-value = NS)		
PARAMETER (%)	EXP (n=64)	CON (n=64)	Average (n=128)
ART line Medication (%)			
Line 1 (%)	84.4	70.3	77.3
Line 2 (%)	15.6	29.7	22.7
Diagnosis (%)			
Mean years since diagnosis (years) (%)	5.55 ±3.784	5.92(±3.717)	5.74(±3.751)
Mean years taking ART (years) (%)	4.91±3.351	5.50(±3.482)	5.21(±3.417)
Smoking Risk (%)			
YES (%)	1.6	0.0	0.8
NO (%)	95.3	96.9	96.1
At times (%)	3.1	3.1	3.1
No of cigarettes/week	2.00(±1.000)	1.50(±.408)	1.75(±2.54)
Alcohol Consumption (%)			
YES (%)	6.3	3.1	4.7
NO (%)	92.2	89.1	90.6
At times (%)	1.6	7.8	4.7
No of pints/week	2.60(±2.074)	1.17(±0.707)	1.89(±1.31)

There were no significant differences between the groups in medication and health risk background. No statistical differences were noted in smoking and alcohol consumption among the participants. Generally, most of the participants neither smoked nor drank alcohol, indicated by the high percentages of 'NO' responses at 96.1% and 90.6%, respectively. In total, only 3.9% of participants revealed that they smoked (on average 1.75 ± 2.54 cigarettes a week while a combined 9.4% of participants confirmed that they drank on average 1.89 ± 1.31 beers per week.

4.3.4. NUTRITIONAL RISK ASSESSMENT

4.3.4.1. DIETARY INTAKE

There was no significant difference between the two groups in terms of eating breakfast, lunch, dinner, eating between/after meals, water consumption, eating at restaurants, eating vegetarian, mineral supplementation, herbal supplementation, use of pills or teas to lose weight and use of protein powders to increase weight. Graphs were used to analyse responses of participants with each dietary intake and no difference (p-value = NS) was noted between the groups.

In total, 58.6%, 57% and 70.3% of participants ate breakfast, lunch and dinner, respectively, on six or seven days every week. The average of participants eating between/after meals several times a week was 44.5%. An average of 44.5% of participants consumed three to five cups of water a day. On average, 78.9% of participants rarely ate at a restaurant; while 26.6% were vegetarian. Regarding mineral and herbal supplementation, an average 96.4% and 91.6% participants, respectively, never took them. None of the participants were using pills or teas to lose weight and 95.3% had never used protein powders to put on weight nor were on special diets for medical reasons. There was no significant difference between the CON group (n=64) and the EXP group (n=64) in all dietary intakes recorded. The Table XIV below shows the dietary intake of participants.

Table xiv: Dietary intake percentages for the EXP group (n =64) and the CON group (n=64)

(p-value = NS)	EXP (n-64)	CON (n=64)	Total Av (n=128)
No. of days eating breakfast/week (%)			
None (%)	0.0	4.7	3
1-2 Days (%)	15.6	12.5	14.1
3-5 Days (%)	32.8	17.2	25.0
6-7 Days (%)	51.6	65.6	58.6
No. of days eating lunch/week (%)			
None (%)	7.8	3.1	5.5
1-2 Days (%)	6.3	12.5	9.4
3-5 Days (%)	28.1	28.1	28.1
6-7 Days (%)	57.8	56.3	57.0
No. of days eating dinner/week (%)			
None (%)	1.6	0.0	0.8
1-2 Days (%)	3.1	4.7	3.9
3-5 Days (%)	31.3	18.8	25.0
6-7 Days (%)	64.1	76.6	70.3
No. of times eating between/after meals (%)			
Daily (%)	3.1	9.4	6.3
Several times/week (%)	40.6	48.4	44.5
≤ once/day (%)	25.0	23.4	24.2
Rarely (%)	31..3	18.8	25.0
Water consumption/day (%)			
< 1 cup (%)	3.1	6.3	4.7
1-2 cups (%)	14.1	12.5	13.3
3-5 cups (%)	46.9	42.5	44.5
> 5 cups (%)	35.9	39.1	37.5
No. of time eating at a restaurant/week (%)			
Daily (%)	0	1.6	0.8
Several times/week (%)	9.4	6.3	7.8
≤ once/day (%)	10.9	14.1	12.5
Rarely (%)	79.7	78.1	78.9
Vegetarian status (%)			
YES (%)	21.9	31.3	26.6
NO (%)	78.1	68.8	73.4
Vitamin/mineral supplementation (%)			
Daily (%)	0.0	1.6	0.8
Weekly (%)	0.0	1.6	0.8
Rarely (%)	3.1	1.6	2.3
Never (%)	96.9	95.3	96.1
Herbal supplementation (%)			
Daily (%)	1.6	3.1	2.3
Weekly (%)	3.1	3.1	3.1
Rarely (%)	3.1	3.1	3.1
Never (%)	92.2	90.6	91.4
Use of pills or teas to lose weight (%)			
YES (%)	0.0	0.0	0.0
NO (%)	100	100	100
Use of protein powders to increase weight (%)			
Daily (%)	3.1	3.1	3.1
Rarely (%)	1.6	1.6	1.6
Never (%)	95.3	95.3	95.3

4.3.4.2. FOOD GROUPS INTAKES

There was no significant difference noted among the groups in most of their food group consumptions, except for bread, cereal, rice and pasta. A chi-square test of independence was performed on cross tabulations to determine any relationships between dietary intake and each group. The Table XV, below, shows food group consumption by participants in the EXP group (n=64) and the CON group (n=64):

Table xv: Food group intake percentages in the EXP group (n =64) and the CON group (n =64)

	(p-value = NS)		
Food Group Intake (in %)	EXP (n-64)	CON (n=64)	Total Av (n=128)
Bread, cereal, rice and pasta intake (%)			
Low intake (%)	93.8	64.1	78.9
Meets requirements (%)	6.3	31.3	18.8
Excessive intake (%)	0.0	4.7	2.3
Fruit and vegetable intake (%)			
Low intake (%)	89.1	81.3	85.2
Meets requirements (%)	10.9	18.8	14.8
Milk, yogurt, and cheese intake (%)			
Low intake (%)	90.6	93.8	92.2
Meets requirements (%)	9.4	6.3	7.8
Meat, poultry, fish, dry beans, eggs, and nuts intake (%)			
Low intake (%)	45.3	45.3	45.3
Meets requirements (%)	37.5	35.9	36.7
Excessive intake (%)	17.2	18.8	18.0
Fat, oils and sweets intake (%)			
Meets requirements (%)	57.8	48.4	53.1
Excessive intake (%)	42.2	51.6	46.9

Figure 4, below, shows the significant relationship between the groups and consumption of foods from group 1 - bread, cereals, rice and pasta.

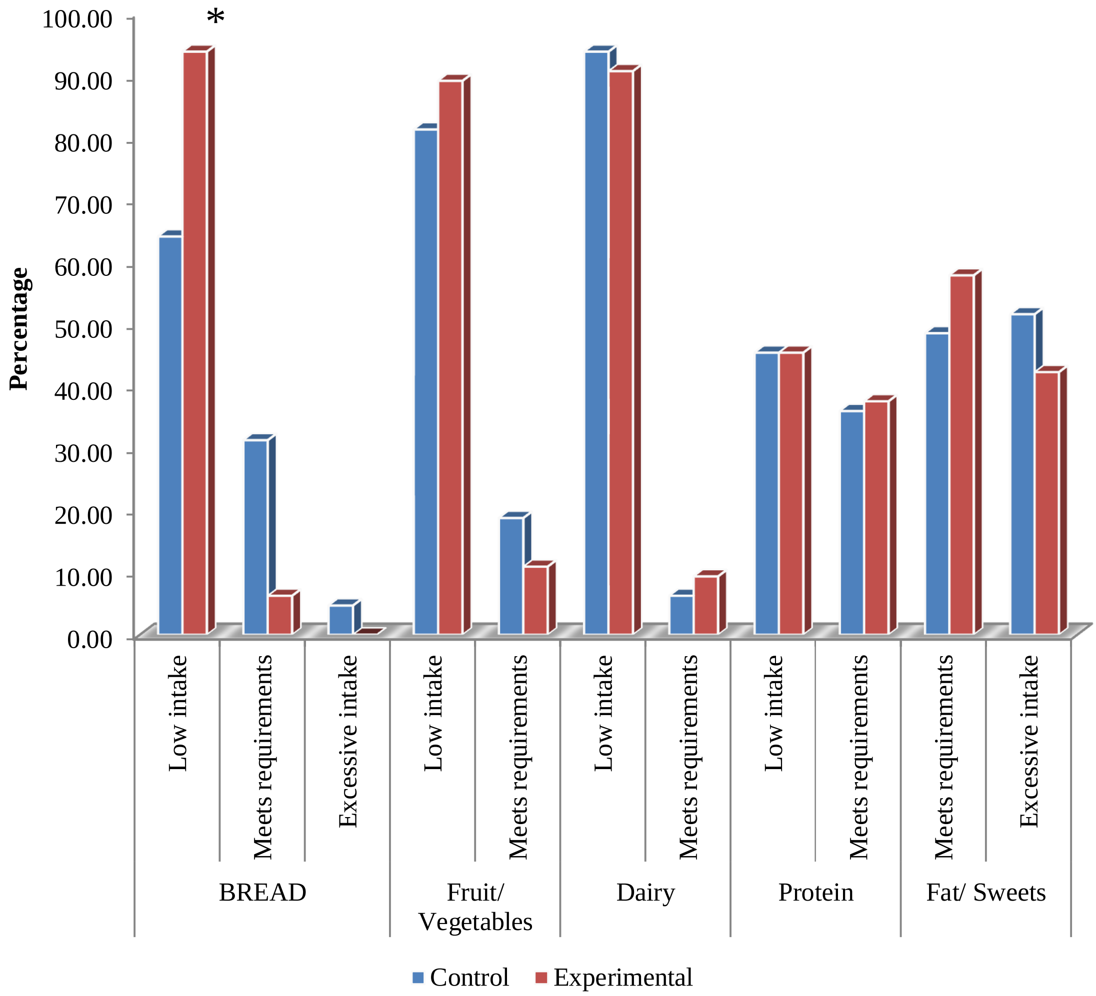

Figure 4: Food group consumptions for the EXP group (n=64) and the CON group (n=64) at pre-test

*= Significant difference (p<.0005) pre-test consumption of food from group one (bread, cereal, rice and pasta) the EXP group (n=64) and the CON group (n=64) pre-test 12 week RE intervention programme.

4.3.4.3. EATING DISORDERS, BODY IMAGE AND WEIGHT MANAGEMENT

A binomial test was conducted to establish the possible existence of eating disorders among participants, from information elicited from their responses for further referral if any. It showed that a significant 84% of the CON group (n=64) participants responded ‘YES’ to fewer than six questions out of a possible fifteen questions intended to identify eating disorders ($p < .0005$). Similarly a significant number (89%) of the EXP group (n=64) responded ‘YES’ to fewer than six of the fifteen questions intended to identify eating disorders ($p < .0005$).

4.3.5. BODY COMPOSITION

ANCOVA was applied to compare body composition variables between the CON group (n=64) and the EXP group (n=64) taking into account variability of other covariates. Post-test scores represented the dependent variable; the covariate was the pre-test scores and the independent variable was the EXP group (n=64) and the CON group (n=64). Significant differences in post-test scores for the EXP group (n=64) and the CON group (n=64) were determined after correcting for the pre-scores. The correcting of pre-test scores was done so that a participant with a high pre-test score could be treated the same as a person with low pre-test for it has the effect of bringing everyone to the same baseline.

There was a significant difference ($p < .0005$) between the EXP group (n=64) and the CON group (n=64) in body composition during post-test although initially there had been no significant differences between the participants pre-test 12 week RE intervention programme. The Table XVI, below, shows mean body composition values for the EXP group (n=64) and the CON group (n=64) at pre-and post-test.

Table xvi: Mean body composition post-test for the EXP group (n =64) and the CON group (n =64)

	(p< .0005).	
BODY COMPOSITION VARIABLE	EXP(n=64) **POST-TEST**	CON (n=64) **POST-TEST**
Weight (kg)	67.50(±15.207)	66.00(±8.154)
Height (cm)	169.95(±7.47)	164.15(±8.907)
Body mass index (kg/m^2)	23.43(±5.475)	24.63(±3.576)
Percentage body fat (%)	19.82(±9.522)	22.70(±6.368)
Fat mass (kg)	14.42(±9.528)	14.67(±5.962)
Lean body mass (kg)	53.07(±8.225)	47.43(±7.829)
Waist circumference (cm)	82.20(±11.029)	78.32(±13.506)
Hip circumference (cm)	98.54(±13.570)	93.81(±16.386)
Waist-hip ratio (ratio)	0.837(±0.080)	0.844(±0.107)

4.3.5.1. WEIGHT

ANCOVA was used to analyse weight between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) weight score was more than that of the EXP group (n=64) once corrected for pre weight. The mean weight of the EXP group (n=64) reduced from 68.03 ± 15.938 kg at pre-test, to 67.50 ± 15.207 kg post-test more likely due to the 12 week RE intervention. This suggests that the RE programme significantly reduced the mean weight score in the EXP group (n=64). The mean weight increased in the CON group (n=64) from 65.97 ± 8.142 kg to 66.00 ± 8.154 kg compared to pre-test. Height did not differ significantly within groups, pre-and post-study. Figure 5 below shows the weight scores for both groups before and after the 12 week RE intervention programme.

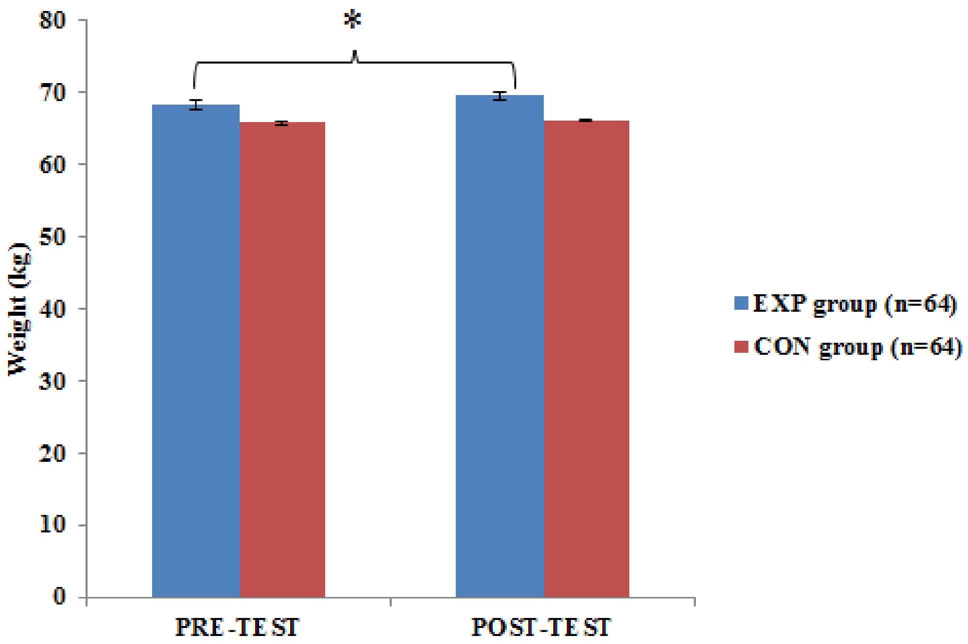

Figure 5: Weight scores for both the EXP group (n=64) and the CON group (n=64) at pre- and post-test

*= Significant difference ($p<.0005$) post-test exercise weight scores of the EXP group (n=64) and the CON group (n=64) pre- to post-test 12 week RE intervention programme.

4.3.5.2. BODY MASS INDEX

ANCOVA was used to analyse body mass index between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) body mass index score was more than that of the EXP group (n=64) once corrected for pre body mass index. There was a significant difference ($p<.0005$) between the EXP group (n=64) and the CON group (n=64) during post-test study. The EXP group (n=64) had a mean body mass index of 23.43 ± 5.475 kg/m^2, while the CON group (n=64) had 24.63 ± 3.576 kg/m^2. Generally, body mass index scores for the EXP group (n=64) suggesting the 12 week RE significantly reduced body mass index in the EXP group (n=64). In the CON group (n=64) body mass index increased at post-test. Figure 6 below shows body mass index in the EXP group (n=64) and the CON group (n=64) pre-and post-test the 12 week RE intervention programme.

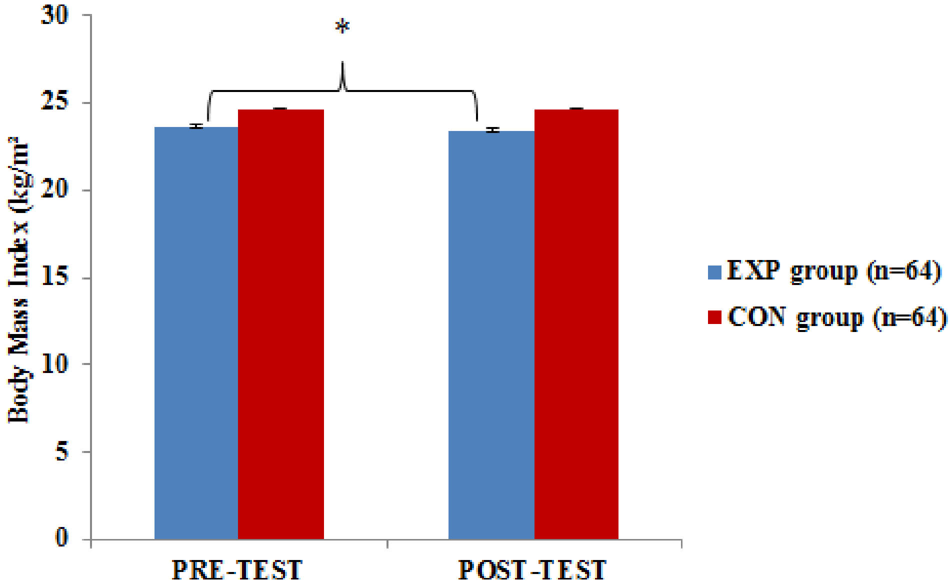

Figure 6: Body mass index scores for both the EXP group (n=64) and the CON group (n=64) at pre- and post-test

*= Significant difference (p<.0005) post-test exercise body mass index scores of the EXP group (n=64) and the CON group (n=64) pre- to post-test 12 week RE intervention programme.

4.3.5.3.PERCENTAGE BODY FAT

ANCOVA was used to analyse percentage body fat between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) percentage body fat score was more than that of the EXP group (n=64) once corrected for pre percentage body fat.

The percentage body fat decreased in the EXP group (n=64) from 21.26 ± 10.017 % to 19.82±9.522 % and increased in the CON group (n=64) from 22.62 ± 6.636 % to 22.70 ± 6.368 % pre-to-post-test 12 week RE intervention programme. The reduction in percentage body fat suggests that the 12 week RE significantly reduced percentage body fat in the EXP group (n=64). Figure 7 shows the significant difference (p<.0005) in percentage body fat between the EXP group (n=64) and the CON group (n=64) from pre-to-post-test study.

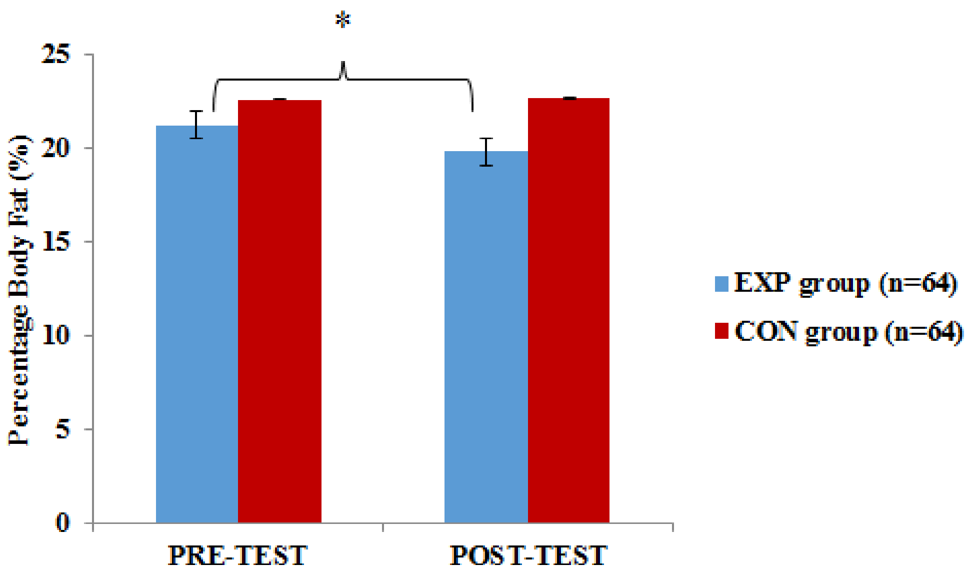

Figure 7: Percentage body fat for the EXP group (n=64) and the CON group (n=64) pre- and post-test study:

*= Significantly higher (p<.0005) mean percentage body fat in the CON group (n=64) than in the EXP group (n=64) post-test 12 week RE intervention programme.

4.3.5.4. FAT MASS

ANCOVA was used to analyse fat mass between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) fat mass score was more than that of the EXP group (n=64) once corrected for pre percentage body fat. Fat mass reduced more in the EXP group (n=64), from 15.67 ± 10.213 kg to 14.42 ± 9.528 kg, than in the CON group (n=64), where it reduced from 15.10 ± 5.523 kg to 14.67 ± 5.962 kg, pre- to post-test 12 week RE intervention programme. The greater reduction in fat mass for the EXP group (n=64) may suggest that the 12 week RE programme significantly reduced fat mass in the EXP group (n=64). Figure 8 shows the significant difference (p<.0005) in fat mass between the EXP group (n=64) and the CON group (n=64) from pre-to-post-test study.

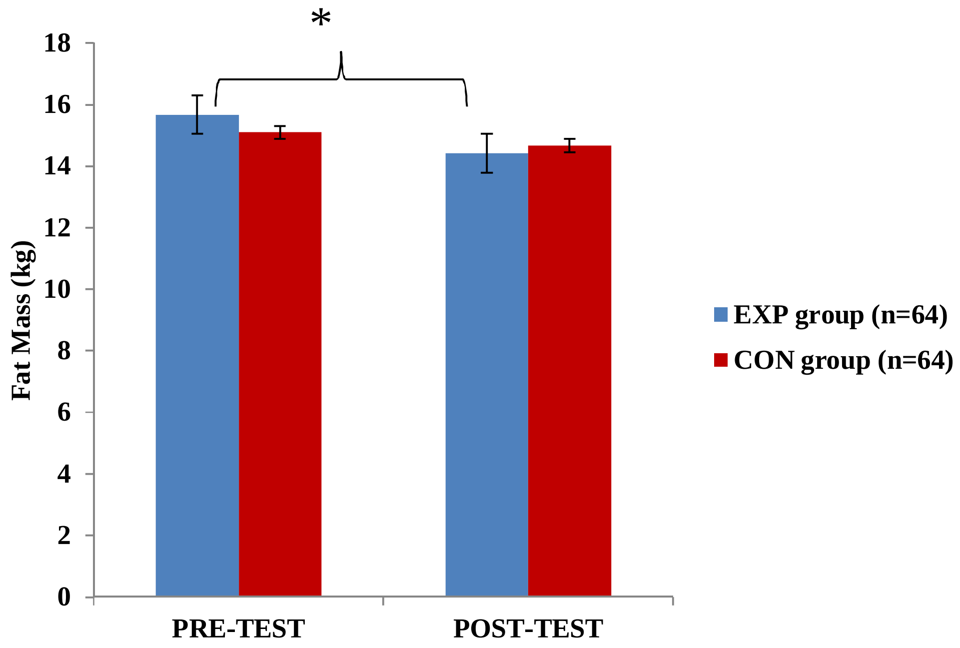

Figure 8: Fat mass for the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher (p<.0005) mean fat mass reduction in the EXP group (n=64) than in the CON group (n=64) post-test 12 week RE intervention programme.

4.3.5.5. LEAN BODY MASS

ANCOVA was used to analyse lean body mass between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The EXP group (n=64) lean body mass score was more than that of the CON group (n=64) once corrected for pre percentage body fat. Lean body mass increased in the EXP group (n=64) from 52.42 ± 8.360 kg to 53.07 ± 8.225 kg, suggest that the 12 week RE intervention programme significantly increased lean body mass in the EXP group (n=64). In the CON group (n=64) lean body mass reduced from 50.87 ± 6.340 kg to 47.43 ± 7.829 kg during the same period. Figure 9 shows the significant difference (p<.0005) in lean body mass between the EXP group (n=64) and the CON group (n=64) from pre-to-post-test study.

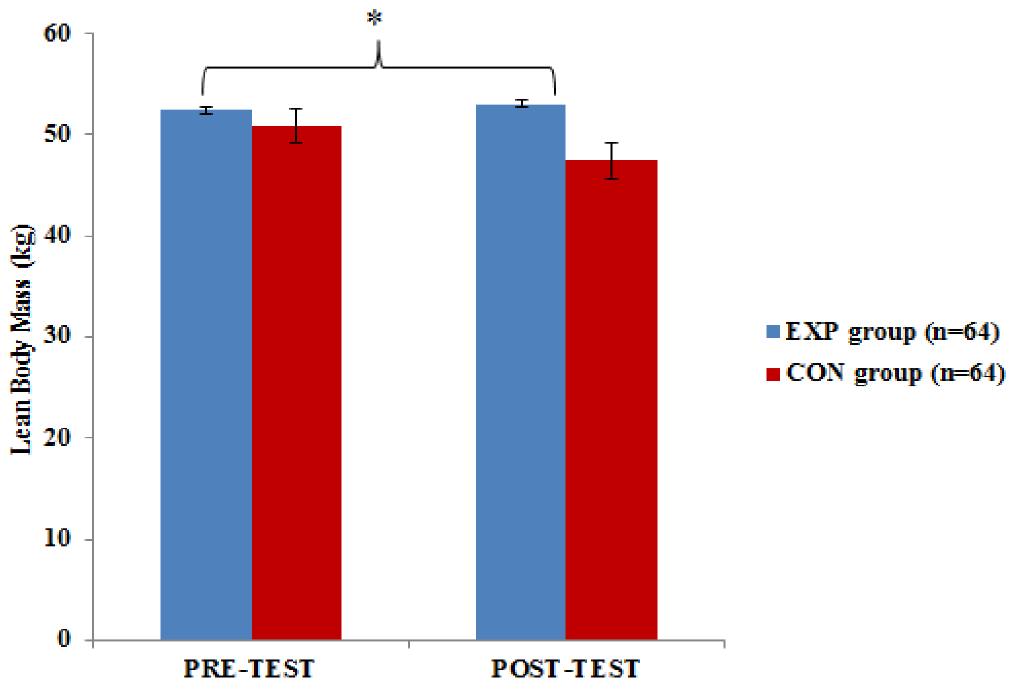

Figure 9: Lean body mass in the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher (p<.0005) mean lean body mass in the EXP group (n=64) than in the CON group (n=64) post-test 12 week RE intervention programme.

4.3.5.6. WAIST–TO-HIP RATIO

ANCOVA was used to analyse waist-to-hip ratio between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) waist-to-hip ratio score was more than that of the EXP group (n=64) once corrected for pre waist-to-hip ratio. Waist-to-hip ratio decreases in the EXP group (n=64) from 0.8562 ± 0.891 to 0.8377 ± 0.080, suggesting that the 12 week RE programme significantly (p<.0005) decreased waist-to-hip ratio in the EXP group (n=64) than in the CON group (n=64) compared to the CON group (n=64), where it increased from 0.831 ± 0.104 to 0.844 ± 0.107 during post- test. There was a decrease in mean waist and hip circumferences for the EXP group (n=64) participants in post-test 12 week RE intervention programme, from 84.34±11.551 cm to 82.20±11.029 cm and 99.00 ± 13.946 cm to 98.54 ± 13.570 cm respectively. The CON group (n=64) participants, however, experienced an increase in waist circumferences at post-test, from 77.90 ± 13.586 cm to 78.32 ± 13.506 cm.

The hip circumferences for the CON group (n=64) participants decreased from 94.56cm to 93.81cm. Figure 10 below shows waist-to-hip ratio classification according to World Health Organisation per percentage of participants in the EXP group (n=64) and the CON group (n=64).

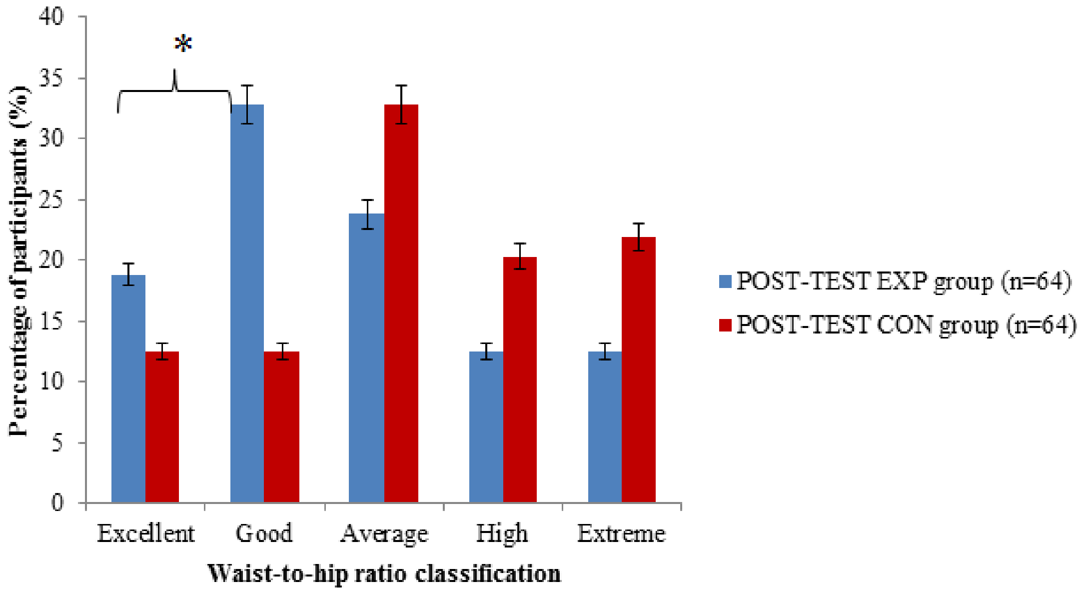

Figure 10: Waist-to-hip ratio in the EXP group (n=64) and the CON group (n=64) pre- and post-test

*= Significantly higher (p<.0005) mean waist-to-hip ratio scores in the EXP group (n=64) than in the CON group (n=64) post-test 12 week RE intervention programme.

4.3.6. CHRONIC DISEASE RISKS

4.3.6.1. TOTAL BLOOD CHOLESTEROL

ANCOVA was used to analyse total blood cholesterol score between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) total blood cholesterol score was more than that of the EXP group (n=64) once corrected for pre total blood cholesterol. This allowed participants to be compared on an equal basis. Total blood cholesterol decreases in the EXP group (n=64) from 4.440 ± 0.526 mmol/l to 4.240 ± 0.488 mmol/l, suggesting that the 12 week RE programme significantly (p<.0005) decreased total blood cholesterol in the EXP group (n=64) than in the CON group (n=64) which increased from 4.556 ± 0.445 mmol/l to 4.672 ± 0.497 mmol/l. The Table XVII below shows mean total blood cholesterol for the EXP group (n=64) and the CON group (n=64) at pre-and post-test (p<.0005).

Table xvii : Mean total blood cholesterol pre-post-test in the EXP group (n=64) and the CON group (n=64)

PARAMETER	p<.0005			
	EXP(n=64)		CON (n=64)	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
Fasting Total Blood Cholesterol (Mmol/L)	4.440(±0.526)	4.240(±0.488)	4.55(±0.445)	4.672(±0.497)

4.3.6.2. FASTING BLOOD GLUCOSE

ANCOVA was used to analyse fasting blood glucose between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The CON group (n=64) fasting blood glucose score was more than that of the EXP group (n=64) once corrected for pre fasting blood glucose. This allowed participants to be compared on an equal basis. Fasting blood glucose decreases in the EXP group (n=64) from 4.440 ± 0.445 mmol/l to 4.240 ± 0.488 mmol/l, suggesting that the 12 week RE programme significantly (p<.0005) decreased fasting blood glucose in EXP group (n=64) than in the CON group (n=64). The Table XVIII below shows mean fasting blood glucose for the EXP group (n=64) and the CON group (n=64) at pre-and post-test.

Table xviii: Mean fasting blood glucose pre-post-test for the EXP group (n=64) and the CON group (n=64)

PARAMETER	p<.0005			
	EXP(n=64)		CON (n=64)	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
Fasting Blood Glucose (Mmol/L)	3.65(±2.722)	2.49(±1.846)	3.68(±0.711)	3.98(±0.818)

4.3.6.3. BLOOD PRESSURE

The Chi-square test of independence was used to determine whether a significant relationship existed between two categorical variables for diastolic and systolic pressure represented in cross tabulation. Blood pressure scores were categorical hence applying chi-square test of independence allowed for analysing the relationship between pre-and post-test blood pressure.The EXP group (n=64) mean systolic and diastolic blood pressure reduced from 126.7 ± 21.326 mmHg to 121.5 ± 21.395 mmHg and from 84.53 ± 13.236 mmHg to 82.92 ± 13.264 mmHg respectively, following the 12 week RE intervention programme.

In comparison, the CON group (n=64) mean systolic blood pressure and diastolic blood pressure increased during the same period from 108.2 ± 10.126 mmHg to 110.7 ± 10.594 mmHg and 79.0 ± 6.410 mmHg to 81.43 ±6.934 mmHg respectively. In the EXP group (n=64) a significant relationship between pre-and post-test scores existed (p<.0005). In this case, a significant 66% of those with hypertension stage 2 at pre-test were classified as having hypertension stage 1 at post-test. This indicates an improvement in blood pressure following the 12 week RE intervention. In comparison to the CON group (n=64), 100% of those with pre-hypertension in pre-test still had pre-hypertension at post-test.

Figure 11 below shows blood pressure classifications of both groups pre-and-post-test study.

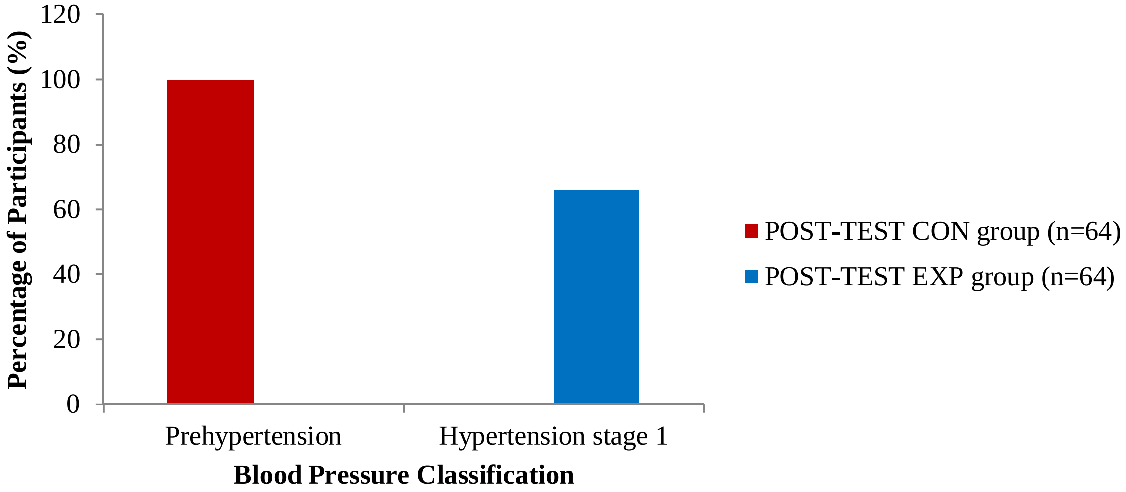

Figure 11: Blood pressure in the EXP group (n=64) and the CON group (n=64) post-test

*= Significantly higher (p<.0005) percentage of participants with prehypertension in the CON group (n=64) than in the EXP group (n=64) post-test 12 week RE intervention programme.

4.3.7. STRENGTH

Individuals' 1RM were used to determine strength levels of each participant at pre-and-post-test. There were notable changes in mean strength levels between the EXP group (n=64) participants and those in the CON group (n=64). The Table XIX shows a summary of mean strength levels of both groups pre-and-post-test.

Table xix: Mean strength levels pre-post-test for the EXP group (n =64) and the CON group (n =64)

	p<.0005			
PARAMETER	**EXP(n=64)**		**CON (n=64)**	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
Bench press (kg)	18.5(±3.99)	22.4(±4.921)	18.8(±7.130)	16.8(±7.348)
Squats (kg)	34.00(±9.63)	60.00(±9.631)	27.3(±9.130)	24.5(±8.813)
Bicep curl (kg)	19.71(±6.29)	27.546(±5.933)	19.3(±6.142)	17.4(±5.895)
Leg curl (kg)	31.26(±9.13)	42.7(±10.025)	26.8(±8.287)	23.2(±8.250)

4.3.7.1. BENCH PRESS

ANCOVA was used to analyse bench press strength between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The EXP group (n=64) bench press strength score was more than that of the CON group (n=64) once corrected for pre bench press strength. There was a significant increase ($p<.0005$) in mean bench press-lifted weight by the EXP group (n=64) participants from 18.5 ± 3.99 kg pre-test, to 22.4 ± 4.921 kg post-test indicating an improvement in bench press strength following the exercise intervention . In comparison, the CON group (n=64) mean bench press-lifted weight reduced from 18.8 ± 7.130 kg at pre-test 12 week RE intervention programme to 16.8 ± 7.348 kg during post-test measurement. Figure 12, below, shows the mean strength difference in the EXP group (n=64) and the CON group (n=64) participants.

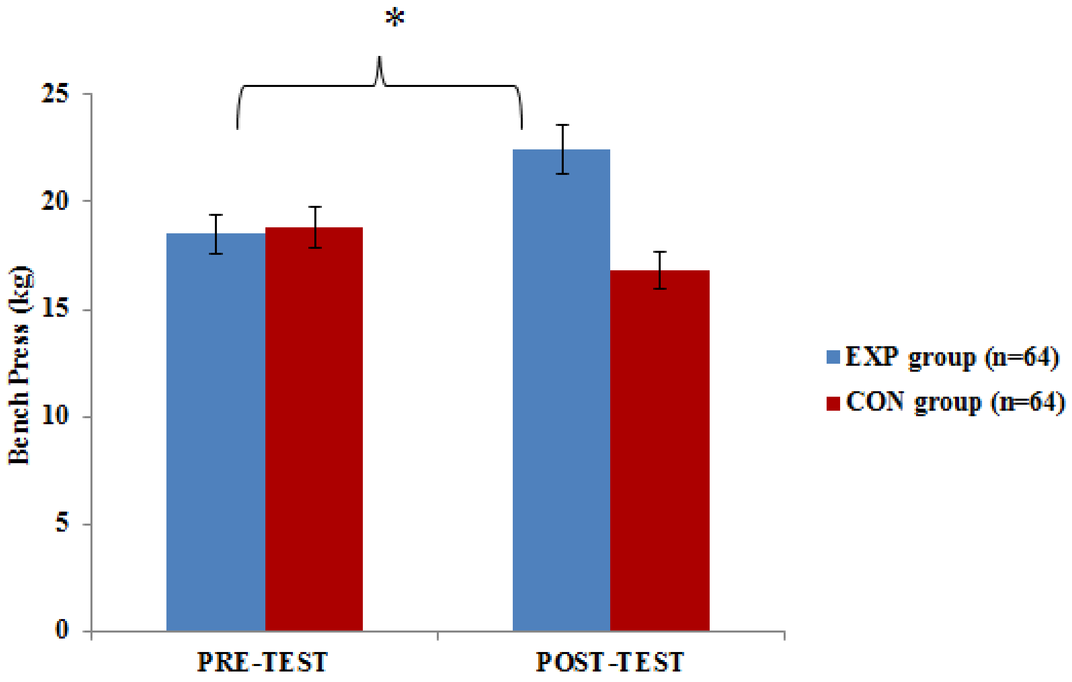

Figure 12: Bench press in the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher ($p<.0005$) mean bench press strength in the EXP group (n=64) than in the CON group (n=64) post-test the 12 week RE intervention programme.

4.3.7.2. SQUAT

ANCOVA was used to analyse squat strength between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. EXP group (n=64) squat strength score was more than that of the CON group (n=64) once corrected for pre squat strength. There was a significant increase ($p<.0005$) in the mean squat-lifted weight by the EXP group (n=64) participants from 34.00 ± 9.63 kg at pre-test to 60.00kg ± 9.631 kg during the post-test. This indicated an improvement in squat strength following the exercise intervention in the EXP group (n=64). In contrast, the CON group (n=64) mean squat-lifted weight decreased from a pre-test measurement of 27.3 ± 9.130 kg to a post-test measurement of 24.5 ± 8.813 kg. Figure 13 shows the differences in the mean squat-lifted weight between the EXP group (n=64) and the CON group (n=64) participants, pre- and post-test period.

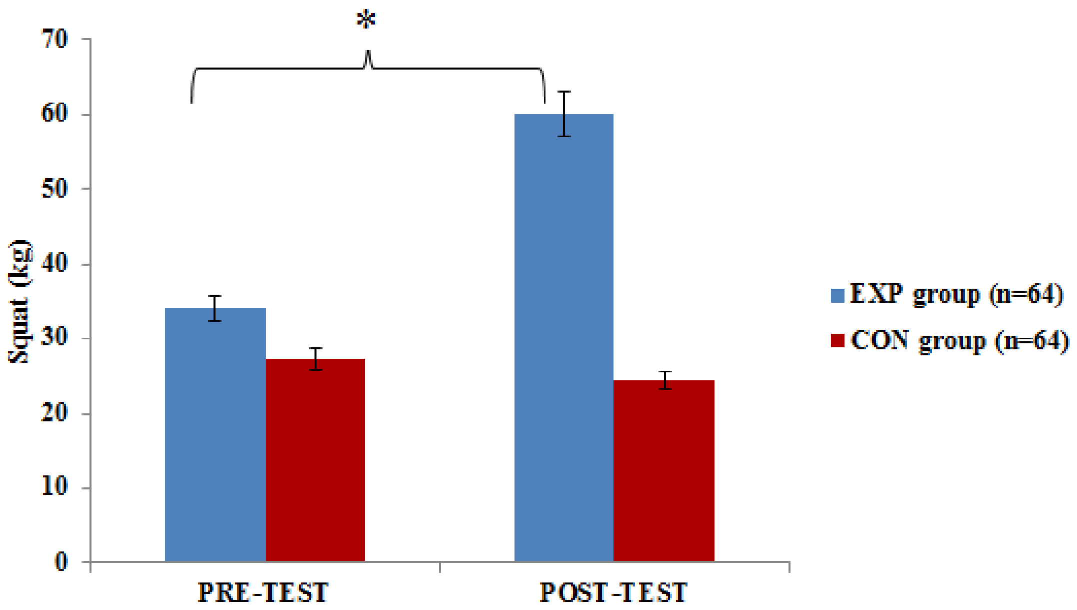

Figure 13: Squat strength in the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher (p<.0005) mean squat strength in the EXP group (n=64) than in the CON group (n=64) post-test 12 week RE intervention programme.

4.3.7.3. BICEP CURL

ANCOVA was used to analyse bicep curl strength between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The EXP group (n=64) bicep curl strength score was more than that of the CON group (n=64) once corrected for pre bicep curl strength. There was a significant increase (p<.0005) in the mean bicep curl lifted weight by participants in the EXP group (n=64) and increased from 19.71 ± 6.29 kg at pre-test, to 27.546 ± 5.933 kg post-test. This indicated an improvement in bicep curl strength following the exercise intervention in the EXP group (n=64). The CON group (n=64) participants had a mean bicep curl lifted-weight of 19.3 ± 6.142 kg at pre-test. At post-test, it decreased to 17.4 ± 5.895 kg. Figure 14 shows changes in the mean bicep curl-lifted weight of the EXP group (n=64) and in the CON group (n=64) participants from pre- to post-test.

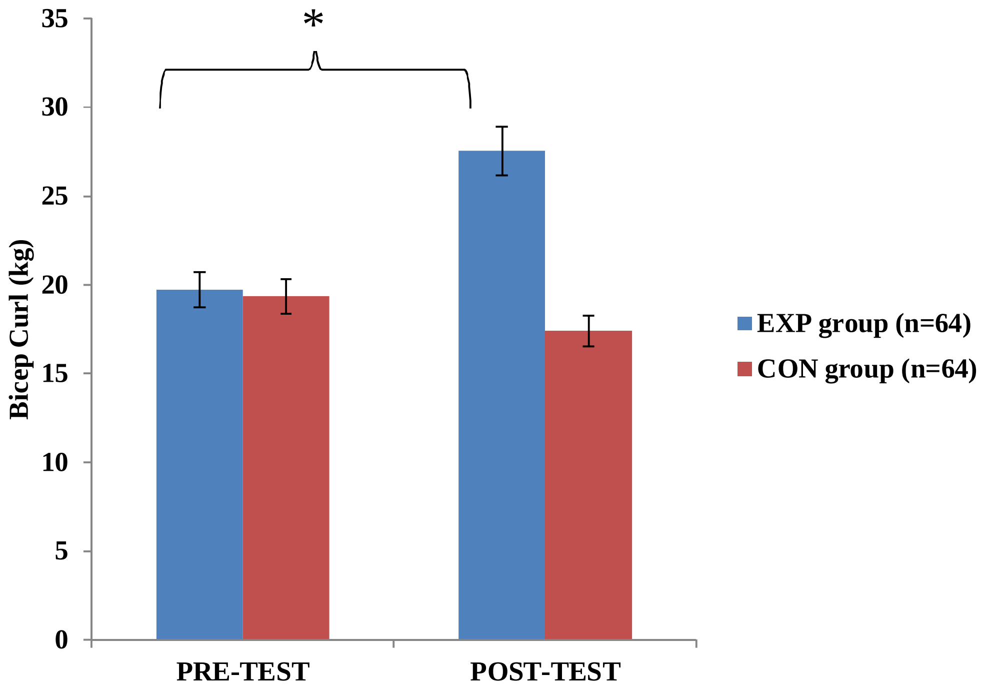

Figure 14: Bicep curl strength in the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher (p<.0005) mean bicep curl strength in the EXP group (n=64) than in the CON group (n=64) post-test 12 week RE intervention programme.

4.3.7.4. LEG CURL

ANCOVA was used to analyse leg curl strength between the EXP group (n=64) and the CON group (n=64) at pre- and post- test. The EXP group (n=64) leg curl strength score was more than that of the CON group (n=64) once corrected for pre leg curl strength. There was a significant increase (p<.0005) in the leg curl-lifted weight for the EXP group (n=64) participants following the 12 week RE intervention programme, from 31.26 ± 9.13 kg to 42.7 ± 10.025 kg, pre- to post-test. This indicated an improvement in leg curl strength following the exercise intervention in the EXP group (n=64). In comparison, the CON group (n=64) participants' mean leg curl-lifted weight decreased from 26.8 ± 8.287 kg to 23.2 ± 8.250 kg in the pre- to post-test 12 week RE intervention programme. Figure 15 shows the difference in mean leg curl weight, pre-and-post-test period.

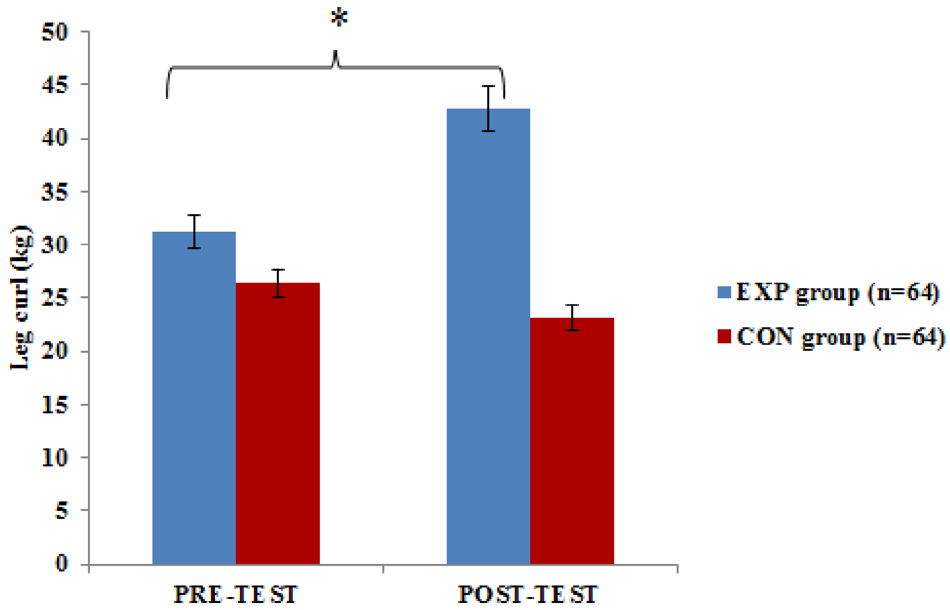

Figure 15: Leg curl strength in the EXP group (n=64) and the CON group (n=64) pre- and post-test study

*= Significantly higher (p<.0005) mean leg curl strength in the EXP group (n=64) than in the CON group (n=64) post-test the 12 week RE intervention programme.

4.3.8. EFFECT OF GENDER

ANCOVA was applied in order to be able to test if the post-test scores differ by gender and needed to be counterbalanced by including the pre-test scores. Gender was used as the fixed factor to test if gender had a significant effect on post-test scores after correcting for the pre-test scores. Gender, instead of group, was used as a fixed factor and analysis was repeated for the two groups separately. The results showed that there was significant (p-value = NS) effect of gender on fasting blood glucose and fasting total blood cholesterol scores at post-test for both groups. There was also no significant difference (p-value = NS) between genders in blood pressure scores at pre-to post-test for the CON group (n=64) participants.

Gender did not have an effect in either group on bench press, squat, leg curl and bicep curl strength at pre- and post-test. There was no effect (p-value = NS) of gender on leg curl strength was noted for the CON group (n=64) in post-test scores.

4.3.9. RELATIONSHIP BETWEEN BODY COMPOSITION, PERIOD ON ART AND CHRONIC DISEASE RISK POINTERS

In analysing the relationship between body composition, ART duration and chronic disease risk indicators, Pearson's correlation was applied to test for associations between them. The blood pressure classification variable was ordinal but not continuous and therefore to analyse associations, Spearman's rho was applied. The Tables XX and XXI below show relationships between study variables

Table xx: Relationships between study variables in the CON group (n=64)

CON group (n=64) at pre-test		
Association between variables	**Statistical Relationship**	**Significance**
Length of time taking ART and weight	r = -0.033	p = 0.797
Length of time on ART and lean body mass	r = -0.095	p = 0.456
Body fat and lean body mass	r = -0.272	p = 0.029
Body mass index and percentage body fat	r = 0.465	p = 0.001
Body mass index and lean body mass	r = 0.313	p = 0.025
Weight and percentage body fat	r = 0.0282	p = 0.024
Weight and lean body mass	r = 0.742	p = 0.001
Fasting blood glucose and fasting total blood cholesterol	r = 0.698	p = 0.000

Table xxi: Relationships between study variables in EXP group (n=64)

EXP group (n=64) at post-test		
Linear relationships between variables	**Statistical Relationship**	**Significance**
Weight and body mass index	r = 0.940	p = .000
Weight and lean body mass	r = 0.724	p = .000
Body fat and lean body mass	r = 0.831	p = .000
Body mass index and percentage body fat	r = 0.803	p = .000
Body mass index and lean body mass	r = 0.689	p = .000
Blood pressure and weight	r = 0.389	p = 0.01
Blood pressure and body mass index	r = 0.355	p = 0.04
Blood pressure and percentage body fat	r = 0.287	p = .022
Fasting blood glucose and fasting total blood cholesterol	r = -0.258	p = .040
Years taking ART and waist-to-hip	r = -0.272	p = .030

4.4. DISCUSSION

This study demonstrates that the 12 week RE intervention programme on PLWHA receiving ART improved their strength, chronic disease risks and body composition. The EXP group (n=64) attained the exercise benefits of the 12 week RE intervention programme than the CON group (n=64) participants. The CON group (n=64) had a higher chronic disease risk, body composition and low strength scores compared to the EXP group (n=64) at post-test 12 week RE intervention programme. In both groups the participants had less intake of fruits and vegetables, while the EXP group (n=64) unexpectedly had higher intake of bread, cereal, rice and pasta. There was no effect of gender relating to response effects to the 12 week RE intervention programme.

Resistance exercise have been used previously to positively address chronic disease risks, body composition and strength scores in PLWHA (Quiles and Ortiz, 2017; Grace et al., 2015; Hand et al, 2009 ; Roubenoff et al., 2002). These studies involved exclusive RE and or in combination with an aerobic component (Leach et al., 2015). Body composition has been positively altered following RE intervention programmes and strength (Anderson, 2006; Phillips et al., 2006; Yarasheski et al., 2001; Hamid and Rajah, 2015; Souza et al., 2011) . In this study there were encouraging responses in strength as it was discovered that it improved by ≥40% with chronic disease risks and body composition scores also improving following the 12 week RE intervention programme.

4.4.1. RESISTANCE EXERCISE AND RESPONSES IN STRENGTH

The study proved that the 12 week RE intervention programme improves strength in PLWHA. This finding is comparable to other studies involving exclusive RE or in combination with other interventions (Garcia et al., 2014; Hamid and Rajah, 2015; Mendes et al., 2013; Roubenoff and Wilson, 2001; Souza et al., 2011). This confirms the evidence that RE produces a dose-response effect on participants (ACSM, 2014, p.9). The study periods observed by various authors ranged from six months to a year and strength increased in all cases. The studies also related to the effect that the RE doses corresponded to participants' 1RMs and progressively increased loads (ACSM, 2014, p.10). The current study observed progressive loading and strength increased from a range of about +4kg to +25kg (for the bench press, bicep curl, leg curl and squat). The findings are similar to studies involving exclusive RE for PLWHA in other countries, (Hamid and Rajah, 2015; Roubenoff and Wilson, 2001; Souza et al., 2011).

The present study relates to an exclusively RE study conducted by Roubenoff and Wilson (2001). Their study recruited an ethnically mixed group of 25 participants (with one female participant) and was a longitudinal study for 16 weeks. Roubenoff and Wilson (2001) showed that RE increased strength of PLWHA by 30% to 50% using 1RM tests. The use of a 12 week RE intervention programme in the present study improved strength of the EXP group (n=64) participants irrespective of gender. In their RE programme, Roubenoff and Wilson, (2001) included double leg presses; leg extensions, seated chest presses; and the use of a seated rowing machine and Keiser pneumatic resistance machines. In the current study, participants however, performed squats, bench presses, bicep curls, and leg curls using free weights according to each individual's 1RM.

In the present study, group participants performed three sets of ten repetitions at 80% of individual 1RM by the 12th week. In a similar approach, Roubenoff and Wilson (2001) participants performed three sets of eight repetitions at 80% of their 1RM in the final training period.

Although, Roubenoff and Wilson (2001), had no CON group, the present study had the CON group (n=64) for comparison purposes. The current study findings relate to another exclusive RE programme for PLWHA by Hamid and Rajah (2015) in India. These researchers used elastic bands in the EXP group and RE without elastic bands in the CON group for 12 weeks. Although, there were no differences in other study variables, the EXP group and the CON group showed significant improvements in peak shoulder lift strength (the EXP group, $p = 0.001$; $p = 0.001$; the CON group, $p = 0.008$; $p = 0.016$) (Hamid and Rajah, 2015). In the current study, the CON group (n=64) participants did not take part in the 12 week RE intervention programme. In comparison, the mean strength levels of the CON group (n=64) participants in the current study as determined by their 1RM tests and decreased over the 12 weeks for squat (-2.8125kg), bench press (-3.0312kg), bicep curls (-1.9531kg) and leg curls (-3.1719kg).

In relation to the current study Souza et al. (2011) conducted a RE programme with PLWHA that had the EXP group and the CON group. The participants trained twice per week, with supervision, for one year. In their reported results, the EXP group had their strength scores increased by about 1.52-2.33 times than at baseline independent of gender, age or pre-test physical fitness scores. Resistance exercise has also proved that they are effective in developing strength when they are conducted in combination with other interventions. It is RE that strengthens muscles. In affirmation, Mendes et al. (2013) conducted a combined aerobic (at progressively increased range of 50-80% of heart rate reserve) and RE (three sets of eight to ten reps up to 80% of 1-RM), programme for 24weeks.

Strength and fitness scores in the PLWHA increased significantly ($P < 0.0001$), (Mendes et al., 2013). Garcia et al. (2014), also conducted a combined exercise programme consisting of RE plus aerobic training (60 min sessions, three times per week) for 20 weeks. The resistance exercise included the ½ squat, bench press, 45° leg press, sit-ups, seated row, leg curl, shoulder press, triceps pulley, biceps curl, seated calf raise and abdominal crunches (Garcia et al., 2014). There were marked improvements in muscle strength for the 45° leg press, seated row, triceps extension, abdominal muscle endurance and VO_2 max after the 24 week training period.

Resistance Exercise stimulates muscle growth leading to increased strength and action of growth-promoting hormones (Evans, 2004). Skeletal muscles become metabolically active due to muscle cell growth and its increased ability to make new proteins (Evans, 2004). Scholars have noticed increases in strength, weight, lean body mass and functional performance in PLWHA following RE intervention programmes though some involved a combination with anabolic steroids (Bhasin et al., 2000; Roubenoff, 2002; Yarasheski and Roubenoff, 2001; Yarasheski et al, 2001). Therefore, preventing sarcopenia and pre-sarcopenia through RE intervention programmes, reduces morbidity and mortalities among PLWHA (Bhasin et al., 2000; Marcell, 2003; Waltson, 2012). The present study was not different since participants in the EXP group (n=64) increased their strength scores post-test 12 week RE intervention programme.

This attests that the current study conforms to similar studies in other countries regarding noting increases in strength among PLWHA following a resistance training programme.

4.4.2. BODY COMPOSITION RESPONSES TO RESISTANCE EXERCISE

It is evident that RE improve lean body mass. Roubenoff and Wilson (2001) found that significant increases were recorded in lean body mass (1.75 (+/- 1.94) kg) of PLWHA similar to other studies following RE (Grace et al., 2015; Gomes-Neto et al., 2013 and Quiles and Ortiz, 2017). The present study also confirms to noticeable increases in lean body mass following the 12 week RE intervention programme in PLWHA. The findings may be compared to Miller.et.al. (2010) study. They conducted a non-randomised resistance and aerobic exercise intervention with 17 participants, for 12 weeks, twice a week. Lean body mass increased compared to baseline scores, with medium changes in trunk adiposity. Although there may be parallels to this study, Miller.et.al. (2010) had included both aerobic and RE.

Agin et al. (2001) found that exclusive resistance training increase body cell mass, among other parameters. Dudgeon et al. (2006) similarly noted that RE programmes have the potential to be a possible alternate to medicinal treatments in improving lean body mass in PLWHA. Walker et al. (2013) concluded that RE programmes provide important health benefits in improving overall body composition levels. The current study showed that the 12-week RE intervention programme improved body composition in the PLWHA in Zimbabwe.

The results from the current study noted the incidence of overweight and obesity among PLWHA in both the CON group (n=64) and the EXP group (n=64). The increased body mass index scores were recorded in the CON group (n=64) and could be as a result of not taking part in the 12 week RE intervention programme, while receiving ART. The higher scores in body mass indexes may have been caused by the consumption of excessive dietary fat, oils and sweets noted at 51.2% in the CON group (n=64) in current study. The EXP group (n=64) had a fairly high intake of dietary fat, oils and sweets recorded at 42.2% in the current study. The present results are similar to those in a study done in Brazil by Jaime et al. (2006), who noted a 45.7% prevalence of central obesity among recruited PLWHA. Furthermore, higher body mass indexes were related to greater ingestion of lipids (Jaime et al., 2006). The consumption rate showed that, for every intake increase of 10g in lipids, the chance of central obesity increased 1.28 times (Jaime et al., 2006). The findings resonate with findings of the current study with reference to the CON group (n=64) participants.

Erlandson et al. (2016) noted that Black and Hispanic ethnicity was associated with greater body mass index and high waist circumferences in PLWHA. All the participants in the current study similarly were of Black ethnic origin, with a higher percentage being women. McCormick et al. (2014) concluded in their study that women of African origin were most affected, with 49% being obese, and a further 32% overweight (body mass index 25–30 kg/m^2). They investigated increasing obesity in 50 female PLWHA receiving ART in SSA from 2011 to 2012. Singh et al (2013) concluded that increased body mass indexes, waist-to-hip ratios and waist circumferences among PLWHA receiving ART are closely associated with developing CVD risks. Therefore chances of this occurring in Zimbabwe may not be ignored as confirmed by results of the current study. The present results showed that the mean weight for the CON group (n=64) participants increased from pre- to post- test since they did not take part in the 12 week RE intervention programme. Therefore, they may have added more fat mass than lean body mass. This in particular relates to a study by Denue et al. (2013) in Nigeria following assessment of body mass index scores in PLWHA over 30 months and found that 83.1% had gained weight.

Furthermore, Guehi et al. (2016) in Côte d'Ivoire researched on the high prevalence of overweight and obesity among PLWHA, pre- and-post 24 months receiving ART. They found that, among the research participants 19.7 % were overweight and 7.2 % were obese at baseline with the factors associated with the condition being female and receiving ART for 5 years. The current study relates well, since females constituted 85.9% and 71.9% in the CON group (n=64) and the EXP group (n=64), respectively; had an average of five years receiving ART.

The present study has showed that PLWHA reflected a 21.1% of the participants ate at fast food restaurants daily or at least more than once a week. The CON group (n=64) participants recorded a higher consumption of bread, cereal, rice and pasta, which may have resulted in increased body mass index values. Issues of underweight were also evident in the current study since minimum body mass index values of 18.30 kg/m^2 and 15 kg/m^2 in the CON group (n=64) and the EXP group (n=64), respectively. Accordingly, Takarinda et.al (2017) alluded to the fact that Zimbabwe faced both under nutrition and overweight disorders among PLWHA which were said to be related to increased incidence of chronic disease and deaths. The authors also referred to this trend as reflecting a change in the pattern of HIV, from being a highly infectious and fatal disease to a chronic manageable condition.

The research findings of current study conform to a study by Engelson et al. (2006). They revealed improvements in body mass index and weight scores following RE intervention for PLWHA. Findings in the current study indicated that there was prevalence of high waist-to-hip ratios among PLWHA. This may be attributed to poor diet, lack of exercise and lack of nutritional knowledge and increases in waist circumference scores at post-test in the CON group (n=64).

The waist-to-hip ratio significantly reduced in the CON group (n=64) following the 12 week RE intervention programme. The findings are in support of a study conducted by Dusingize et al. (2013) in Rwanda. The authors noted that PLWHA had mean waist-to-hip ratios ranging between 0.88 ± 0.07; 0.89 ± 0.08 and 0.87 ± 0.08 ($p = 0.21$). The sedentary lifestyles of individuals in the current CON group (n=64), are associated with a greater risk of heart disease, according to the (WHO, 2013). The findings are in line with a study conducted by (Romancini et al., 2012).

They investigated the levels of physical activity and metabolic alterations in 65 PLWHA and found out that 64.6% were sedentary, with only 35.4% active, after receiving ART for at least five years (Romancini et al., 2012)

Yarasheski et al. (2001) findings further reveal that whole-body lean mass increased by 2.5% (1.4 kg), in those with wasting condition, following 64 sessions of resistance training by 18 asymptomatic HIV-infected males without lipodystrophy, receiving ART. Similarly, the present 12 week RE intervention programme reduced body mass index scores in the EXP group (n=64) participants as well as improved weight scores and wait-to-hip ratios in PLWHA. The fat mass scores decreased significantly in the EXP group (n=64) (1.25%) following the 12 week RE intervention programme. Furthermore, there was a significant improvement in mean percentage body fat, lean body mass suggesting they may have been shedding off fat. By contrast, the mean percentage body fat in the CON group (n=64) participants increased, lean body mass decreased suggesting they may have been losing muscle and amassing fat. The current findings therefore, relate to those of other similar studies (Grace et al., 2015; Gomes-Neto et al., 2013; Quiles and Ortiz, 2017).

4.4.3. EFFECT OF RESISTANCE EXERCISE ON CHRONIC DISEASE RISKS

The findings in the present 12 week RE intervention programme show that they relate to other studies that have involved RE for PLWHA receiving ART and noticed improvements in chronic disease scores (Garcia et al., 2014; Lindegaard et al., 2008; Mendes, 2011; Souza et al., 2011; Yarasheski et al., 2001). The 12 week RE intervention programme reduced fasting blood glucose and fasting total blood cholesterol levels in PLWHA. Therefore, the intervention can be said to have improved the body systems of PLWHA in using and controlling blood glucose. The ability of the body to utilize and control blood glucose reduced the risk of suffering from type 2 diabetes in PLWHA (Colberg, 2010).

Therefore RE increase uptake of glucose through transfer, carriage through the muscle tissue and intracellular fluid during glycolysis process (Boule et al., 2005; Colberg, 2010; Sylow.et al., 2017). Participating in a RE intervention programme stimulates the body to shift its source of energy reliance from free fatty acids to fat, muscle glycogen and glucose (Sylow et al., 2017). The accompanying chronic responses to REs are increase in muscle mass known as hypertrophy which increases the amount of glucose transporters influencing blood glucose utilisation and metabolism at rest or during physical activities (Sylow et al., 2017).

This also increase the ability to attain glucose homeostasis among participants (Sylow et al., 2017). The current 12 week RE intervention improved the fasting total blood cholesterol in the body contributing to the reduction of chronic disease incidence (ACSM, 2014:294).

The findings in the present study relate to Souza et al. (2011) following an exclusively progressive RE intervention on PLWHA. Souza et al. (2011) found that the RE intervention improved their fasting blood glucose levels. Further, it also showed a tendency to reduce blood lipids in PLWHA after a year's training programme whose study period was different from the current study. Although the improvements were more pronounced among those not using protease inhibitors (Souza et al., 2011), the present study also noted the improvements in fasting total cholesterol on a shorter period of time.

Yarasheski et al. (2001), also conducted a RE programme with PLWHA. Although fasting serum triglyceride concentrations were reduced, fasting total cholesterol, insulin and glucagon concentrations were not affected after the exercise training programme. Study designs, participants' age, number of participants, family background and duration of study, medication, exercise dose and diets may influence different findings among researchers. The variances in blood lipid findings between Yarasheski et al. (2001) study and the present study might be due to variances in the research designs and the fact that the present study only focused on fasting total blood cholesterol and not low density lipoprotein-cholesterol or high density lipoprotein-cholesterol levels specifically.

The current study concurs to noting improvements in strength as was discovered by Hamid and Rajah (2015) following a RE programme. However the current study further discovered that blood glucose and fasting total blood cholesterol improves besides strength as the only variable that can be focused on when conducting RE for PLWHA. Other study finding with similar results as the current 12 week RE intervention programme involved an aerobic component (Mutimura et al., 2008; Thoni et al., 2002). Lindegaard et al. (2008) conducted a supervised resistance and an endurance training three times a week for 16 weeks. The researchers found that RE decreased triglycerides, free fatty acids, and increased high-density lipoprotein cholesterol. The current study concurred to the study by Lindegaard et al. (2008) although this current study managed to obtain similar outcomes in 12 weeks using RE exclusively. Mendes (2011) then conducted a 12-week progressive RE programme with an aerobic component on an HIV-infected Caucasian woman. Similarly, findings showed that the participant exhibited reductions in her total triglycerides (9.9%), total cholesterol (12.0%) and low-density lipoprotein cholesterol (8.6%) after the 12 weeks. In similar discoveries the present study although with a larger percentage of women participants there was a decrease in total fasting blood cholesterol among males as well following an exclusive RE programme.

Martinez et al. (2007) and Teklay et al. (2013) reported that smoking and alcohol are risk factors that accelerate the adverse hepatic chronic disease risks in PLWHA receiving ART. The current study also discovered that there were the same risk factors whose prevalence was beginning to be noted among study participants in Zimbabwe. Garcia et al. (2014), following a combined resistance and aerobic exercise training programme on PLWHA found that blood glucose remained stable and total cholesterol decreased. The parallels may be drawn with the current study since it was discovered that the total fasting blood glucose levels decreased following a 12 week PE programme. However Garcia et al. (2014) involved a combined resistance and aerobic exercise program while the current study only involved exclusive RE. Further, this study discovered that fasting total blood cholesterol decreased after only using an exclusive RE programme compared to a combined aerobic and RE study carried out by (Garcia et al., 2014). Junior et al. (2010) in Pernambuco Brazil, found that the recruited PLWHA had high fasting total blood cholesterol (> 200 mmol/l), high blood glucose levels (> 100 mmol/l), and triglyceride values (> 150 mmol/l) which were associated with hypertension. However, Dolan et al. (2006), following an aerobic and resistance training programme with PLWHA found no significant changes in blood pressure.

The current study then discovered that blood pressure decreased following the 12 week RE intervention programme. Similarly Baechle (2008:111) asserted that, resting blood pressure may decrease slightly or not change, at all following resistance training. This study therefore discovered that both systolic and diastolic blood pressure decreased by 2% to 4% suggesting the positive effect of the RE programme.

In current study it was further noted that the decrease in blood pressure were greatest in those individuals with initial high blood pressure scores and a number of participants with hypertension stage 2 improved to hypertension stage. However, recent studies by O’Brien et al. (2017) and Quiles and Ortiz (2017) did not investigate the effect of RE on blood pressure in PLWHA.

Generally, the current study findings were not different to studies in other countries.

4.5. LIMITATIONS

The sample size of current study was small and the period was short. The use skinfolds as a field measurement to obtain body composition is dependent on measurer's experience and may have contributed as a limitation to the study since no advanced tool was used for this variable.

The findings are not a one size fit all since participants were only recruited from high density community of Harare. Counter activities and other confounding issues made participants and research assistants miss or skip some sessions as the economic situation was not very favourable.

The participants were asked to be in a fasted state prior to measuring fasting total blood cholesterol and fasting blood glucose. However, it was difficult to measure participants' compliance with such a request. Hence participants that would have not heeded the request meant distortions in measured variables.

4.6. CONCLUSION

The study established the effect of a 12-week RE programme on body composition in PLWHA in Zimbabwe. The findings in this study are comparable to those done in other countries. The RE intervention programme had a positive effect on participants. Improvements were noticeable in body mass index, waist-to-hip ratios, percent body fat, lean body mass, fat mass, strength, blood pressure, blood cholesterol and blood glucose among PLWHA. The PLWHA in Zimbabwe seem to have been exposed to urbanisation hence health and dietary lifestyles may imitate those of developed nations. The use of ART further exposes PLWHA to chronic disease risks. Resistance exercise for PLWHA in Zimbabwe receiving ART is probably the next feasible option to address chronic disease risks.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

The findings of various studies support the role of exercise in benefiting PLWHA receiving ART. The findings of these studies show that ART increases life expectancy (Ciccolo et al., 2014). However, chronic disease risks (lipodystrophy, high blood pressure, high fasting blood glucose, increased fasting total blood cholesterol, high waist-to-hip ratio scores, overweight, obesity, reduced mineral bone density, osteopenia) begin to affect PLWHA after they have been receiving ART in the middle to long term. The data presented may serve to alert Sub-Saharan African nations, where significant numbers of individuals receive ART. Non-communicable diseases in PLWHA raise health bills, unless deliberate measures are put in place to lessen their destructive effect. The failure to address such an epidemiological trend will undermine current efforts aimed at increasing life expectancy of PLWHA in Africa. The reviewed studies show that current expectations are for PLWHA to utilise natural methods, like RE, as a strategy to cope with chronic disease risks (Ciccolo et al., 2004). They show that utmost concern needs to be taken in managing chronic disease risks in the PLWHA receiving ART. It is believed that this should be done by focusing on increasing their life expectancy through the inclusion of exercise intervention programmes (Stein, 2010). A number of studies have thus been conducted to examine the effect of exercise on the utmost self-reported chronic disease risks in PLWHA receiving ART.

Therefore, it is increasingly becoming more imperative to come up with RE programme strategies for PLWHA to enhance their quality of life and body composition (Ciccolo et al., 2004). The chronic disease risks in PLWHA which include changes in body composition, call for non-medicinal interventions to limit the burdens on the already drug-dependent body of an HIV-infected individual. Exercise is seen as a valuable adjunct therapy to ART in PLWHA. It positively addresses body composition, chronic disease risks and improves strength in PLWHA. Resistance exercise is also ideal for PLWHA.

There is limited data in Africa, particularly in Zimbabwe, concerning the use of RE to combat chronic disease risks in PLWHA receiving ART. It shows that more research is needed in Zimbabwe to examine the effect of complementary lifestyle strategy, involving RE, to improve strength and chronic disease risks in PLWHA.

5.2. RECOMMENDATIONS

It is recommended that further studies on RE for PLWHA be done in Zimbabwe to check on the validity and reliability of these interventions. The studies to follow may also include profiling the drives of PLWHA to adhere to an exercise as a critical variable for it indicates sustainability of such programs in communities.

A home based RE programme for PLWHA may also be structured basing on the current study design so as further cater for this population in the comfort of their own homes without incurring extra transport and nutritional provisions. This would limit challenges faced by the current research team to provide these during and after sessions since the 2015-16 economic environments were challenging and relying on a college grant whose exchange rate was pegged against a stronger currency.

The other recommendation is that a similar study may be done using advanced tools to assess body composition such as dual energy x-ray absorptiometry since in this study only the skinfold calliper were used. These are field measurements that rely on experience of a qualified Kinathropometrist.

It is recommended that for studies of this nature in future the research team should come up with a resource funding option so as to cater for food and transport reimbursements commensurate with prevailing economic conditions.

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APPENDICES

APPENDIX A: MRCZ ETHICS APPROVAL

Telephone: 791792/791193
Telefax: (263) - 4 - 790715
E-mail: mrcz@mrcz.org.zw
Website: http://www.mrcz.org.zw

Medical Research Council of Zimbabwe
Josiah Tongogara / Mazoe Street
P. O. Box CY 573
Causeway
Harare

APPROVAL

REF: MRCZ/B/948 **18 December 2015**

Victor Mbayo
University of KwaZulu Natal
School of Health Sciences
Howard College Campus
Private Bag X54001
Durban

RE:- The effect of resistance exercise on HIV infected patients taking Antiretroviral Therapy (ART) in Zimbabwe

Thank you for the application for review of Research Activity that you submitted to the Medical Research Council of Zimbabwe (MRCZ). Please be advised that the Medical Research Council of Zimbabwe has reviewed and approved your application to conduct the above titled study.

This approval is based on the review and approval of the following documents that were submitted to MRCZ for review:-

a) Study proposal
b) Informed Consent forms (English and Shona)
c) Data collection Tools (English and Shona)

- **TYPE OF MEETING** : Expedited
- **EFFECTIVE APPROVAL DATE** : 18 December 2015
- **EXPIRATION DATE** : 17 December 2016

After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the MRCZ Offices should be submitted three months before the expiration date for continuing review.

•**SERIOUS ADVERSE EVENT REPORTING:** All serious problems having to do with subject safety must be reported to the Institutional Ethical Review Committee (IERC) as well as the MRCZ within 3 working days using standard forms obtainable from the MRCZ Offices or website.

•**MODIFICATIONS:** Prior MRCZ and IERC approval using standard forms obtainable from the MRCZ Offices is required before implementing any changes in the Protocol (including changes in the consent documents).

•**TERMINATION OF STUDY:** On termination of a study, a report has to be submitted to the MRCZ using standard forms obtainable from the MRCZ Offices or website.

•**QUESTIONS:** Please contact the MRCZ on Telephone No. (04) 791792, 791193 or by e-mail on mrcz@mrcz.org.zw

Other

- Please be reminded to send in copies of your research results for our records as well as for Health Research Database.
- You're also encouraged to submit electronic copies of your publications in peer-reviewed journals that may emanate from this study.

Yours Faithfully

....

MRCZ SECRETARIAT
FOR CHAIRPERSON
MEDICAL RESEARCH COUNCIL OF ZIMBABWE

MEDICAL RESEARCH COUNCIL OF ZIMBABWE
2015 -12- 18
APPROVED
P.O. BOX CY 573 CAUSEWAY, HARARE

PROMOTING THE ETHICAL CONDUCT OF HEALTH RESEARCH

APPENDIX B: BREC ETHICS APPROVAL

UNIVERSITY OF KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI

19 January 2016

Mr V Mbayo (214584884)
Biokinetics, Exercise and Leisure Sciences
School of Health Sciences
vmbayo@gmail.com

Dear Mr Mbayo

Protocol: The effects of resistance exercise on HIV infected patients taking antiretroviral therapy (ART) in Zimbabwe.
Degree: MSc
BREC reference number: BF293/15

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application at a meeting held on 08 September 2015.

Your responses dated 18 December 2015 to queries raised on 02 December 2015 have been noted and approved by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given **full ethics approval** and may begin as from 19 January 2016.

This approval is valid for one year from **19 January 2016.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

Pg. 2/...

Biomedical Research Ethics Committee
Professor J Tsoka-Gwegweni (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 2486 **Facsimile:** +27 (0) 31 260 4609 **Email:** brec@ukzn.ac.za

The following Committee members were present at the meeting that took place on 08 September 2015:

Prof J Tsoka-Gwegweni	Chair
Dr C Aldous	Genetics
Prof R Bhimma	Paediatrics & Child Health
Rev. S D Chili	External - Lay member
Prof A Coutsoudis	Paediatrics & Child Health
Dr T Hardcastle	Surgery
Dr R Harrichandpersad	Neurosurgery
Mr H Humphries	Research Psychology and Public Health
Dr M Khan	Obstetrics and Gynaecology
Prof TE Madiba	General Surgery
Dr NR Maharaj	Obstetrics & Gynaecology
Ms T Maistry	External - Microbiology
Dr K Naidoo	Family Medicine
Dr S Paruk	Psychiatry
Prof A Ross	External - DUT - Homoeopathy
Prof V Rambiritch	Pharmacology (Deputy Chair)
Prof C Rout	Anaesthetics
Prof D Wassenaar	Psychology (Deputy Chair)

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

This approval will be ratified at the next BREC meeting to be held on 09 February 2016.

Yours sincerely

PROFESSOR J TSOKA-GWEGWENI
Chair: Biomedical Research Ethics Committee

cc: supervisor: [illegible]
cc: Postgraduate Office

APPENDIX C: MINISTRY OF HEALTH AND CHILD CAREGATEKEEPER'S APPROVAL

Telephone: +263-4-798537-60Telegraphic Address:
"MEDICUS", Harare
Fax: +263-4-729154/793634
(702293 FHP)
Telex: MEDICUS 22211ZW

Reference:
Ministry of Health and Child Care
P O Box CY1122
Causeway
HARARE

7 October 2015

1701 Kuwadzana 2
Dzivarasekwa
Harare

Attention: Victor Mbayo

REF: Recommendation letter and validation of Nutritional Questionnaire for Research – The effect of resistance exercise on HIV infected patients taking ARVs in Zimbabwe.

The above subject refers.

This is in response to your request to have the Ministry of Health and Child Care, recommend your study and validate the Nutritional recall questionnaire.

The MoHCC recommends that you do a "before and after" study rather than an experimental study where one group is told not to exercise for a period of time. This might have ethical issues. Rather identify a study population of people who do not exercise then do baseline tests, then reassess them after a period of time where they were exercising and analyse your results.

The tool which you attached is approved. You can use it to determine Nutritional recall.

Good luck in your studies and hopefully you will be able to share your results with the Ministry.

Regards

Brigadier General (Dr) G. Gwinji
SECRETARY FOR HEALTH AND CHILD CARE

SECRETARY FOR HEALTH & CHILD CARE
(01) SECRETARY OFFICE (01)
0 9 OCT 2015
P.O. BOX CY 1122, CAUSEWAY
ZIMBABWE

APPENDIX D: NATIONAL AIDS COUNCIL GATEKEEPER'S APPROVAL

☏ 263-04 749 790
749 791

Email:
nacharare@gmail.com

NATIONAL AIDS COUNCIL
HARARE PROVINCE
NO. 154 SAMORA MACHEL
AVENUE WEST
BELVEDERE
HARARE
ZIMBABWE

19 October 2015

TO WHOM IT MAY CONCERN

RE: APPROVAL FOR VICTOR MBAYO TO RECRUIT SUBJECTS FOR A RESEARCH.

We hereby support and formally approve Mr. V. Mbayo to recruit subjects for his study titled: The effect of resistance exercise on HIV infected patients taking antiretroviral treatment (ART) in Zimbabwe.

The research subjects sought are those taking ART and being followed on an out patient basis.

We look forward to your assistance for Mr. V Mbayo to undertake this study.

Sincerely

MR A. MUZONDIONA
PROVINCIAL AIDS COORDINATOR/HARARE

NATIONAL AIDS COUNCIL
HARARE PROVINCE
19 OCT 2015

APPENDIX E: ZNNP+ GATEKEEPERS' APPROVAL

ZIMBABWE NATIONAL NETWORK OF PLHIV (ZNNP+)

ZNNP+

P.O. Box BE255 Belvedere, Harare
Tel.: 263-4-741824

28 Divine Road
Milton Park
Harare

22 October 2015

To whom it may concern

REF: Approval for Victor Mbayo to recruit members from ZNNP+ in a research study

We hereby formally confirm and approve that Victor Mbayo (Student no// 214584884) who is undertaking master's study in Biokinetics and Exercise Science at the University of Kwazulu Natal can work with ZNNP+ members in his research.

We are looking forward to work together and support you (Victor Mbayo) until the time you finish your research. If you require any assistance please let us know on time and kindly use contact details indicated below.

We wish you all the best in your studies and we hope you will have an opportunity to share your results with us.

Yours faithfully

Manhiri

Esnath Ndazonakei Manhiri

Harare Provincial Coordinator (0773 761 567 or 0716 548 287)

APPENDIX F: DISTRICT COUNCIL AND GYM GATEKEEPER’S APPROVAL

CITY OF HARARE

GLEN VIEW COMMUNITY CENTER NUMBER 3

Corner 11 Street / Patrenda Way.

04- 690290

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16 October 2016

To Whom It May Concern:

REF: CONFIRMATION LETTER FOR VICTOR MBAYO

This letter serves to confirm that Victor Mbayo will train PLWHA, at Glen View Community Center Number 3 Gym for the Research titled, "The EFFECT OF RESISTANCE EXERCISES ON INDIVIDUALS TAKING ART."

We therefore support the study and approve of the arrangement.

For any other information please contact the under signed.

Yours sincerely

L.Mazikana

Cell number: +263775897550

SOCIAL WORKER

APPENDIX G: INFORMATION SHEET

UNIVERSITY OF KWAZULU-NATAL

THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

INFORMATION SHEET FOR PARTICIPANTS

I hereby greet and welcome you to this study. Victor Mbayo is my name and undertaking a Masters' degree with University of KwaZulu Natal. I am studying on the above stated topic. I thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you of any kind and we thank you for considering this request.

This study involves preliminary screening for selection purposes. If you decide to participate, you will be required to fill in a questionnaire to obtain your general information, dietary background and physical activity readiness. You will also undergo some preliminary baseline procedures to determine your blood sugar, blood lipids (good and bad fats), percentage body fat and body dimensions (like size, shape, mass, height, percentage body fat) using a skinfold calliper, tape measure and steel ruler. Once these baseline checks are done, following a medical doctor's approval you will be required to undertake a weight lifting procedure to determine the maximum weight that you can lift only once without experiencing fatigue while applying maximum effort (i.e. 100% exertion). This is known as your one repetition maximum (1RM). You will randomly be allocated to an experiment or control group. Therefore, being allocated to an experiment group one will undergo a resistance exercise (supervised weight lifting) programme twice a week for 12 weeks at a local gym. Then, if allocated to a control group you will not be involved in the supervised weight lifting (resistance) exercise programme during the 12 week period. The random assigning to a control or experiment group is necessary to allow everyone a chance to be allocated to any of the groups without bias. This also provides a significant opportunity for the study to investigate the effect of resistance exercise on individuals taking antiretroviral treatment.

It is important to note that, those allocated to a control group will benefit greatly from the study although they will not take part in the exercise training.

This is so because the developed program and gym membership cards will be exclusively availed to all participants after the study. Therefore, if benefits to resistance training are shown then the control group will also be offered the intervention. You will be assigned a numerical identification code rather than using your actual name so to safeguard anonymity.

What is the Aim of the Project?

This project is being undertaken as part of the requirements for a postgraduate Master's degree in Sports Science. The main aims of this project are:

1. The first aim is to investigate associations between body composition, period of taking ART and comorbidity risk pointers in PLWHA.

2. The second aim is to investigate the effect of resistance exercise on body composition in PLWHA.

What Type of Participants are Needed?

This study involves PLWHA male, female, of 18-45 years, receiving ART, not taking part in any gym exercise program and medically approved will participate in a 12 week resistance training program.

Participants who fall under one or more of the categories listed below will not be able to participate in the project because, in the opinion of the researchers and the Ethics Committee of the University, it may lead to unfavourable outcomes of the study, or involve an unacceptable risk to them:

- Not within the age group limit of 18-45years
- Non-Black Africans
- Patients or individuals with AIDS
- Musculoskeletal disorders.
- Seriously ill and bed redden individuals
- With CD4 count less than 350 cells/mm^3,
- HIV Negative individuals
- Any history of leg injury and back pain
- Those with congestive heart failure, angina, cardiovascular and peripheral vascular diseases.
- Individuals who experience a cold or feverish illness at least 1 month leading up to the protocol and those with flu symptoms.
- Individuals taking medications that may affect central or peripheral circulation.
- Those on nonsteroidal anti-inflammatory agents or serotonin reuptake inhibitors.
- Currently engaged in an existing exercise programme.
- Any other medical condition that would be exacerbated by lifting weights.

What will Participants be asked to do?

Should you agree to participate in this project, you will be asked to fill out forms and be involved in a testing protocol. Written informed consent will be obtained from all participants, and the study will be approved by the University of KwaZulu-Natal Research Ethics Committee.

Preliminary research study tests will be conducted at the community centre. You will attend four sessions, that is; a preliminary screening phase 1, being the first visit lasting no longer than 50 minutes. Phase 2, a baseline information-lab test session being the 2nd visit lasting approximately 1 hour 30 minutes each for four days (to take blood pressure, glucose, lipids, anthropometric measures and establishing of 1RM values. Anthropometric measurements are a technical procedure undertaken to determine one's body dimensions (i.e. size, shape, mass, height, percentage body fat) using a skinfold calliper, tape measure and steel ruler among others. One repetition maximum (1RM) is the maximum weight that one can lift only once without experiencing fatigue while applying maximum effort (i.e. 100% exertion). All participants will be availed with gym membership cards to be able to access the gym. Control group members shall retain gym membership cards after the 1RM procedure only be given back after the study.

Phase 3, which will be the 3rd visit, consists of a 12 week resistance exercise intervention on a frequency of 2 days.wk-1 commencing with a one and a half weeks conditioning session. At this stage, participants in the experiment group will perform strength exercises on each of the two days. Participants will get an opportunity to strengthen the biceps, triceps, chest, calf, hamstrings and quadriceps muscles. It will be achieved through performing the following exercises: body weight exercises, preacher curls, triceps extensions, bench press, leg curls, squats and calf raises. Initially experiment group subjects will work out at 50% of individual 1RM performing 3 sets of 10 repetitions observing 2 minutes rest during the first two weeks. The percentage of 1RM will be progressively increased to 60% and 65% observing the same number of repetitions and time of rest from week 3 to 6th week. This will be followed by progressively increasing the load from 70% to 75% and 80% of individual subjects' 1RM performing 2 sets of 8 repetitions observing 3 minutes rest from the 7th to 12th week.

This will be done in a circuit training format. Workouts will be done with the assistance of a spotter. The participants will be expected to maintain a high-calorie diet and rehydrate during the resistance exercise sessions. During this phase, participants will go through a 10-20 minute warm up involving light jogging, stretches, light weight exercises and 8-10 minutes cool down exercises. Each of the sessions will run for 30-50 minutes per day. The control group participants will not undergo any exercise training intervention during the same period.

Phase 4 will be the 4th visit and shall consist a post-test-activity session. Participants will have their baseline-lab tests (anthropometrics, body composition, blood; pressure, glucose and lipid level and1RM tests) measured again at 6th and 12th week. The phase is expected to last for approximately 1 hour (+/-).

Y	N

The following tests and evaluations will be performed:

Preliminary Screening: You will be required to complete the enclosed personal/medical history form. The purpose of completing this form is to ensure that you meet the inclusion requirements of the study, and that the researcher obtains necessary information about your lifestyle including physical activity. You will be required to complete an approved questionnaire by filling in your information regarding demographics, nutritional recall, medical history and Physical Activity Readiness. Y N

Pre-testing: You will be required to have baseline lab-tests performed to determine your anthropometric value, body composition, blood pressure, blood glucose, blood lipids and 1RM tests. The tests procedure will take approximately 1 hour 30minutes (+/-). Y N

(a). **Anthropometric measurement procedure**

The procedure will be done observing highest levels of privacy and you will be measured by a research team member of the same gender with you. You will have minimal clothing and without shoes when these measurements will be taken. A stadiometer and an electronic scale will be used to measure stature and mass respectively.

You will stand with the feet together and the heels, buttocks and upper part of the back touching the scale in an anatomical position.

The measurer will place hands far enough along your jaw for ensuring an upward pressure to be transferred through your bony prominence that projects out from both sides of skull behind the ears and hinge of jaw. You will take and hold a deep breath keeping the head straight up in a firm and stable positon. The recorder will place the head board firmly down on the top of the head (vertex) to crush the hair as much as possible. The recorder further assists by watching that your feet will not come off the floor. Your height measurement will be taken at the end of the inward breath. To measure your weight, you will be required to stands on the central platform of the scale without support ensuring that the weight is distributed evenly on both feet. These measurements will be done observing ISAK protocol.

(b). Body composition procedure Y N

Your restricted profile will be measuring taking seven (7) skinfold site (triceps, chest, abdominal, subscapular, suprailiac, mid-axilla and front thigh) to determine your amount of body fat. You will be expected to have minimal clothing when these measurements are being taken. Measurements will be done observing International Society for the Advancement of Kinanthropometry protocols using anthropometric equipment (skin fold callipers, anthropometric tape, steel ruler, demographic pen, retractable metric tape measure). Your skinfold site will be carefully located using the correct anatomical landmarks.

Your skin will be marked using a tipped felt or dermographic pen for all skinfold landmarks. A skinfold will be picked up at marked lines. On each site, researcher will lightly grasp / pinch you with the thumb and index finger. The site will be lifted so that a double fold of skin plus the underlying subcutaneous adipose tissue is raised. A caliper will be applied 1 cm away from the edge of the thumb and finger and measurement recorded.

Y N

(c) Blood Pressure Measurement Procedure

Cuff and monitor will be positioned on flat-solid surface, and your upper arm inserted into the brachial cuff. The tubing will be positioned on the middle part of your arm to allow sensors to pick a signal. The brachial cuff will be placed on the main artery on the inside part of your arm. The bottom edge of the cuff will be about 3 cm from the elbow joint, pulling the end of the cuff to evenly tighten it round your upper arm, to fit comfortably. Your elbow will be rested with palm flat on the table. The monitor will be switched on to inflate the cuff automatically and you will sit quietly without moving. Your pulse as well as blood pressure (diastolic and systolic) readings will be automatically reflected on the monitor after some few seconds and recorded. After recording, the cuff will be let loose ensuring that it is deflated and reset to measure the next participant.

Y N

(d) Blood tests procedure

You will be allowed to rest for 5 minutes before taking the blood tests to stabilise the body. You will be made to sit comfortably on a chair with good back support at a table or desk and you will not eat, drink or smoke before or while your blood test is being taken. The feet flat on the floor. Constrictive jewellery and clothing will not be expected to be put on if they seem to interference with the procedure. Repeat measurements will be done to ensure accuracy.

Y N

d. (i) Blood Glucose Measurement Procedure

In the sitting position you will be expected to offer your preferred fingertip to be lanced with a lancet after being swabbed with cotton dampened in alcohol sterilizing solution. Then a drop of blood from the side will be drawn. You will be made to touch and hold the end of the test strip inserted into the meter/monitor so that the drop of blood gets absorbed into the strip to begin the test. Your test results will be displayed on the monitor screen after a beep and results recorded.

A swab will be used to wipe the finger after the test observing WHO guidelines on drawing blood: best practices in phlebotomy and clinical health standards.

Y N

d.(ii) Blood Lipids/ Cholesterol Collection Procedure

A second prick can only be done for this procedure if necessary. Therefore, the alcohol swabbed and initially pricked finger in above (for blood glucose measurement) will then be lightly squeezed once again to collect the blood that comes out to be drawn into a capillary tube which should be filled up to the black check line. Capillary tube will not touch the finger or be allowed to have bubbles. Blood collection for this procedure will be done within 30 seconds. You will be given a cotton swab to hold, press on the lanced finger and band it with an Elastoplast. A plunger will be used to apply the entire blood sample into the test strip. Your results will be displayed on the monitor after a few minutes and the total cholesterol, LDL and HDL level readings recorded. The used capillary tube, cotton swab, test strip, and lancet will be disposed properly and machine reset to test another participant. This will be done observing WHO guidelines on drawing blood: best practices in phlebotomy and clinical health standards.

Y	N

(e). 1RM test procedure

Your current strength levels will be determined using 1RM tests (for bench press, squat, bicep curl and leg press 1RM). You will be led through a warm up performing submaximal repetitions of specific exercises to be used and the whole procedure done following ACSM Guidelines for Exercise Testing and Prescription protocol. The rest to be observed between each 1RM test procedure will be 48hours. The 1RM will be determined within four lifts observing 3-5 minutes rests with help from a spotter. Normative data for predicting 1RM will be used to select weights that are within your perceived capacity (i.e. 50-70%). Weights will be progressively added by 2.5-20kg until you can no complete a repetition. Therefore, previous weight you would have lifted successfully will become the 1RM for that exercise. The lifted 1RM values for each exercise will be recorded and test results used to design your resistance exercise program, especially for experiment group members.

Y	N

(f) Post-test-activity procedure

You will have your baseline-lab tests anthropometrics (body size, height, percentage body fat, blood; pressure, glucose and lipid level and strength tests) measured again at 6 and 12th week to assess progress. The results obtained will be analysed to draw conclusions and recommendations.

Y	N

<u>Possible risks and discomforts:</u>

Anthropometric Measures: Stature and mass measurements will produce no physical discomfort.

Body composition Measures: The participant will be required to wear minimal clothing and this will bring minimal or no discomfort.

Blood Samples: The blood samples will involve lancing the finger with a lancet and therefore there will be minimal discomfort.

Blood Pressure Measures: Blood pressure will be taken using electronic monitors and will produce no physical discomfort.

1RM test: Lifting of weights bring about some discomfort and fatigue hence rest periods, rehydration periods will be observed.

Resistance exercise: Weight training brings about muscle soreness and fatigue hence, exposes you to some level of discomfort. This occurs to anyone who starts an exercise after being physically inactive for 6-7 months or never been physically active. Conversely, this will subside in less than 6 days.

The measurements will be taken observing all issues of privacy and confidentiality hence each participant will be measured by a research assistant of the same gender in designated testing rooms for males and for females. Ethical principles of respect for persons, beneficence (doing good) and justice will be strictly followed for your safety. Your right to self-determination will observed, without exposing you to harm or discrimination, in keeping to our agreement respecting cultural differences, preserving your anonymity in compliance with procedures and reports of violations.

Blood glucose and cholesterol measures will be taken by a trained research and medical personnel team the presence of a first aider who will explain to you the procedure beforehand. Strict safety precautions will be followed. Hence the testing team will wear latex gloves during these procedures with appropriate clothing and follow guidelines for safe handling of samples and disposal in plastic sharps bins before incineration at the end of the whole session. Therefore your lanced finder will be swabbed with an alcohol swab. The lanced site will be cleaned using cotton balls and wrapped with an Elastoplast finger bandage.
The 1RM and exercise session will be done after a trained sport and exercise specialist would have taken you for a warm.

When you partake in the session adequate rest periods will be given and a spotter assisting you during these procedures. You will also be trained in gym basics prior to the sessions. In cases of experiencing delayed onset of muscle soreness, a massage therapist will be in attendance every other rest day as well as the medical doctor to attend to you. The opportunities for more rest will be given when you need it. Mineral water will be available during these sessions so as showers.

Potential benefits of this study:

Should the study yield significant results, the proposed benefits of the study include opportunities for participant to track and have blood pressure, blood sugar and blood lipid levels checked on a regular basis. It is also strongly anticipated that you will get an opportunity to have body composition profiling in relation to period you have been taking ART. This would in turn allow you to know your anthropometric scores in establishing health bench marks for consideration to partake in a physical fitness exercise program for your benefit. Also that, those found at risk of suffering from other ailments like diabetes mellitus, obesity, high blood pressure and high blood lipid levels after the study will be referred by a medical doctor for counselling and be provided with healthy physical lifestyle recommendations for adoption while continuing to participate in the study. Once the exercise intervention is found to yield significant benefits, all participants will be given the programme and encouraged to sustain it as healthy lifestyle practice. Furthermore, the study may facilitate for a better understanding and appreciation of the importance of resistance exercise for HIV-infected members of the population.

Will I Be Reimbursed For Participating In The Study?

Participants in the study will be provided with a beverage and a snack by the research (at US$0.50/ R7 a beverage and US$1.50/R21 for a snack) and reimbursed transport at R15 per visit.The payments will be based on Time, Inconvenience and Expenses (TIE) method.

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participation in the project at any time without any disadvantage to yourself of any kind.

What Data or Information will be collected and What Use will be made of it?

The information will facilitate for evaluation of whether resistance exercise has an impact on the body composition profiles of PLWHA. It can assist in establishing whether body composition profiles relate to time one has been taking ART. The information obtained will be used to provide awareness into the role resistance exercise have on the overall wellbeing of PLWHA.

Results of this project may be published but, any data included will in no way be linked to any specific participant. Therefore, you are most welcome to request a copy of the results of the project should you wish. Although every effort will be made to keep the information confidential, in special circumstances BREC and some Zimbabwean Regulatory department may be given access to the confidential information.

The data collected will be securely stored in such a way that only those mentioned above will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

What do participants have to avoid prior to testing?

Participants will be instructed not to eat, drink or smoke before or while blood test will be taken.

What if Participants have any Further Questions?

If you have any further questions regarding this study, please feel free to contact: -

Takshita Sookan

Discipline of Biokinetics,

Exercise and Leisure Sciences

Telephone Number 031 2607987

This project will be reviewed and approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal.

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

University of KwaZulu-Natal

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001, Durban, 4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: BREC@ukzn.ac.za

APPENDIX H: INFORMED CONSENT

UNIVERSITY OF KWAZULU-NATAL

THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

Finally, I understand that:

1. My participation in the project is entirely voluntary.
2. I am free to withdraw from the project at any time without any disadvantage.
3. The data will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.
4. Firstly I am required to fill in a questionnaire. Secondly I understand that there are baseline tests that include blood capillary draw, some tests require minimal clothing and that I will be required to lift weights. Thirdly I will complete the resistance exercise intervention which may cause some discomfort. Hence, I understand that there is a level of discomfort. I may be placed randomly into an experiment or control group for a period of 12 weeks.
5. There is reimbursement of transport in this study.
6. The results of the project may be published but my anonymity will be preserved.
7. That I will keep a copy of this consent form and I will receive a report of my results, if requested I am entitled to a copy of the study.

I agree to take part in this project.

.... ……………………..

Signature of participant Date

……………………………………………… ……………………..

Witness Date

APPENDIX I: QUESTIONNAIRE

UNIVERSITY OF KWAZULU-NATAL

THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

Introduction

Warm greetings to you. I am Victor Mbayo from the University of KwaZulu Natal undertaking a study on the effect of resistance exercise on HIV-infected patients taking antiretroviral therapy (ART) in Zimbabwe**.** This questionnaire seeks to obtain valuable information from you and value your honest detailed responses. You are kindly requested to fill in or by ticking were relevant. The questionnaire should take approximately 20-30 minutes of your time to complete. Your responses are completely anonymous and information you provide will be handled with highest degree of confidentiality and secrecy.

A. Demographic Information

Please tick/ fill in the questionnaire were appropriate.

1. What is your Gender Male ☐ or Female ☐

2. Age Range 18-29 ☐ 30-41 ☐ 42-53 ☐ 54-60 ☐

3. Level of education

   Non-Formal ☐ Primary ☐ Secondary ☐ Certificate ☐ Tertiary

Other____

4. Marital Status

   ☐ Single ☐ Married ☐ Divorced

B. General Physical Activity Readiness and Exercise Adherence

7. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor? YES ☐ NO ☐

8. Do you feel pain in your chest when you do physical activity? YES ☐ NO ☐

YES	NO	
☐	☐	9. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	10. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	11. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
☐	☐	12. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	13. Do you know of any other reason why you should not do physical activity?

14. Which form or type of exercise/ physical activity do you participate in

Walking ☐ Jogging ☐ Gym Work Outs ☐ I do not exercise ☐

Any other____

15. How much time do you spend exercising/ doing physical activity per week

Less than 30minutes ☐ 30minutes- 1Hour ☐ More than 1 Hour ☐ None ☐

16. How often do you exercise/ do physical activity per week:

1-2times/wk ☐ 3-4 times/wk ☐ More than 4times ☐ None ☐

17. Would you be interested in taking part in some form of exercise for health reasons?

Yes No ☐ ☐

C. Health Background

18. In which year were you diagnosed positive _________

19. Which year did you start taking ART ___________

20. Which ART medication are you taking _______________________________________

D. Risk Assessment

21. Are you ☐ a Smoker ☐ or Non Smoker ☐ At times

22. If yes in above how many cigarettes per day on average__________________________

23. When did you quit smoking ______ years/weeks/months ago or Never smoked ☐

24. Do you take alcohol: Yes ☐ No ☐ At times ☐

25. If yes in above how often________________and how much in quantity___________

26. When did you quit taking alcohol_____ years/weeks/months ago or ☐ Never took alcohol

27. Have you been diagnosed hypertensive (High BP): Yes ☐ No ☐

or on hypertensive medication: Yes ☐ No ☐

28. Are you diabetic? Yes ☐ No ☐

E. Nutritional risk assessment

29. Circle the answer which best describes your usual behaviour

DIETARY INTAKE - HABITS

How many days each week do you eat breakfast?	None	1-2 days	3-5 days	6-7 days
How many days each week do you eat lunch?	None	1-2 days	3-5 days	6-7 days
How many days each week do you eat dinner?	None	1-2 days	3-5 days	6-7 days
How often do you eat between meals or after dinner?	Daily	Several times /week	Once/week or less	Rarely
How much water do you drink each day?	<1 cup	1-2 cups	3-5 cups	>5 cups
How many times per week do you eat or take out a meal from a fast food restaurant?	Daily	Several times/week	Once/week or less	Rarely
Are you a vegetarian?	Yes		No	
Do you take any vitamin or mineral supplement?	Daily	Weekly	Rarely	Never
If yes, which brand or type:				
Do you use herbal supplements?	Daily	Weekly	Rarely	Never
If yes, which one(s)?				
Do you use any pills or teas to lose weight?	Yes		No	
Do you use protein powders, creatine or other supplements that claim to increase muscles?	Daily	Weekly	Rarely	Never
Are you on a special diet for medical reasons?	Yes		No	

FOOD GROUPS: BREAD, CEREAL, RICE, AND PASTA

Serving Size	**Food Item**	**Servings per day**	**Servings per week**	**Eat once a month or less**	**Never eat**
1 slice	Bread				
1/2	Hamburger or hot dog bun				
1/2	English muffing, bagel, pita bread				
4-6	Crackers				
1-6 inch	Tortilla				
1 small or 1/2 large	Muffin, *biscuit				
2 medium	Pancakes				
2 small	Waffle				
1/2 cup	Hot cereal				
3/4 cup	Cold Cereal				
1/2 cup	Rice, cooked				
1/2 cup	Pasta (spaghetti, noodles, macaroni, etc.), cooked				
TOTAL # OF SERVINGS:					

FRUITS AND VEGETABLES

Serving Size	Food Item	Servings per day	Servings per week	Eat once a month or less	Never eat
1 medium	Fresh apple, pear, banana, orange, peach, nectarine, tomato				
½	Grapefruit				
2	Apricots, tangerines				
¼	Cantaloupe				
1 cup	Melon, cut up				
3/4 cup	Berries				
1/2 cup	Pineapple, fresh				
1/2 cup	Canned or frozen fruit				
1/4 cup	Dried fruit (raisins, apricots, dates				
3/4 cup	100% vegetable juice				
1 cup	Leafy green vegetables				
1/2 cup	Vegetables, raw or cooked				
1 medium	Potato, baked, boiled, or mashed				
TOTAL # OF SERVINGS:					

MILK, YOGURT, AND CHEESE

Serving Size	**Food Item**	**Servings per day**	**Servings per week**	**Eat once a month or less**	**Never eat**
1 cup	Unflavored Milk*				
1 cup	Fat free milk				
1 cup	Yogurt				
1-2 ounces	Cheese*				
1 cup	Cottage cheese*				
11⁄2 cup	Frozen yogurt				
11⁄2 cup	Ice cream*				
11⁄2 cup	Pudding,* custard				
8 ounces	Fortified unflavored soy milk				
1 cup	Unflavored Milk*				
TOTAL # OF SERVINGS:					

MEAT, POULTRY, FISH, DRY BEANS, EGGS, AND NUTS

Serving Size	**Food Item**	**Servings per day**	**Servings per week**	**Eat once a month or less**	**Never eat**
3 ounces	Cooked beef, pork or lamb				
3 ounces	Cooked chicken, turkey or duck				
3 ounces	Fresh or frozen fish, cooked				
3 ounces	Shellfish				
3 ounces	Lunch meats*				
	Hot dogs				
3 ounces	Tuna or other canned fish				
3	Eggs (1 egg = 1 oz. meat)				
9 ounces	Tofu (3 ounces = 1 oz. meat)				
6 Tbsp	Peanut butter*				
11⁄2 cup	Legumes, cooked or canned: [lentils, beans (pinto, navy, kidney, garbanzo), split peas, black-eyed peas]				
	Nuts and seeds				
TOTAL # OF SERVINGS:					

FATS, OILS, AND SWEETS

Serving Size	Food Item	Servings per day	Servings per week	Eat once a month or less	Never eat
2	Cookies				
1	Brownie				
1	Donut or sweet roll				
1	Granola bar				
1	slice cake or pie				
1⁄2 cup	Pudding, custard, Jello, ice cream, sherbet				
1	Chocolate bar, M and Ms or candy (1 pkg)				
1 tbsp	Sugar, honey, jam, jelly, syrup				
12 ounces	Soda (not diet) (1 can)				
1 cup	Fruit flavored, sugar sweetened drinks (lemonade, fruit punch, KoolAid, Hi-C, Sunny Delight)				
1 tsp	Butter or margarine				
1 Tbsp	Mayo, salad dressing, sour cream				
1 Tbsp	Cream cheese				
1 Tbsp	Vegetable oil				
TOTAL # OF SERVINGS:					

BODY IMAGE, DISORDERED EATING, AND WEIGHT MANAGEMENT

Do you worry about gaining weight?	Yes	No
Are you preoccupied with losing weight?	Yes	No
Are you on a diet or do you limit your food intake to lose weight?	Yes	No
Does your mood depend on your weight (e.g., if you gain one pound you are depressed, irritable, etc.)	Yes	No
Do you feel bad about yourself if you gain weight?	Yes	No
If you gain one pound, do you worry that you will continue to gain weight?	Yes	No
Do you think of certain foods as being either "good" or "bad" and feel guilty about eating "bad" foods?	Yes	No
Do you use foods to comfort yourself?	Yes	No
Do you ever feel out of control when eating?	Yes	No
Do you spend a significant amount of time thinking about food and when you will eat?	Yes	No
Do you vomit or have you thought about vomiting as a way to control your weight?	Yes	No
Do you try to hide how much you eat?	Yes	No
Do you use laxatives, water pills, exercise, etc., to prevent weight gain?	Yes	No
Are you dissatisfied with your body size or shape?	Yes	No
Do you eat until you feel stuffed?	Yes	No
Total number of "yes" answers =		

THANK YOU

APPENDIX J: ATHROPOMETRIC RECORDING SHEET

THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

Name/Code: ___________________________ Age: _____________________________
Contact No: ____________________________
Gender: Male or Female
Date of Test: ___________________________________
Test number: ___________________________________

Measurement	**Ser**	**Site**	**1**	**2**	**3**	**Mean/Median**
Basic	1	Weight/Body Mass (kg)				
	2	Stature/Height (cm)				
Skin folds	3	Triceps (mm)				
	4	Chest (mm)				
	5	Abdominal (mm)				
	6	Subscapular (mm)				
	7	Mid-axilla (mm)				
	9	Front Thigh (mm)				
	10	Suprailiac (mm)				
Girths	11	Waist (cm)				
	12	Hip (cm)				

Body Mass Index: = $\frac{\text{Weight}}{\text{Height}^2}$ [ ]

Sum of 7 mean Skin folds = [ ]

Waist-Hip Ratio = Waist [ ]

Hip

APPENDIX K: CHRONIC DISEASE RISKS RECORDING SHEET

THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

Name/Code: ___________________________ Age: _____________________________
Contact No: ____________________________
Gender: Male or Female
Date of Test: __________________________________
Test number: __________________________________
Starting time: __________________________________

Measure or Test	Level/Reading	Units
Systolic Blood Pressure		mm Hg
Diastolic Blood Pressure		mm Hg
Fasting Total Blood Cholesterol		mmol/L
Blood Glucose		mmol/L

Finishing time: ____

Comments:
____
____
____
____
____
____
____

APPENDIX L: ONE REPETITION MAXIMUM RECORDING SHEET

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THE EFFECT OF RESISTANCE EXERCISE ON HIV-INFECTED PATIENTS TAKING ANTIRETROVIRAL THERAPY (ART) IN ZIMBABWE

Name/Code: ________________________ Date: _____________________________

Gender:________________________ Weight: ________ in Kg _________ in lbs

Age: ________________________ Mode or type of lift: _________________

Estimated 1RM _______________________ in Kg ________________________ in lbs

Warm Up

1. _______ reps @ ____________ Kg or ________lbs (at ≈ 50% of estimated 1RM)

2. _______ reps @ ____________ Kg or ________lbs (at ≈ 60-70% of estimated 1RM)

1RM Testing (*please circle success or failure with each attempt*)

1st attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

2nd attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

3rd attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

4th attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

5th attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

6th attempt: Success / Failure, lifting ______________ Kg, ________________ in lbs

Established 1RM per Body weight _________________ = _____.

Percentile rank classification for 1RM in lbs per body weight, in lbs _______, in Kg _______

Comments:

____

____

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APPENDIX M: WORKOUT RETURN FORM

Effect of resistance exercise on HIV-infected patients taking (ART) in Zimbabwe

Goal: ....

Identifiable Patient/ Name Code: ....   Date: ....

Starting time: ....   Finishing time: ....

Week	Type of Exercise	Working	%1 RM	Volm	Weight	Reps	Sets	Rest	Remarks
Week ______ Day ______									
	Leg Curl	Hams							
	Bench Press	Chest							
	Bicep Curl	Biceps							
	Squats	Quads							
Week ______ Day ______	Squats	Quads							
	Chest Press	Chest							
	Preacher Curls	Biceps							
	Leg curls	Hams							
Week ______ Day ______	Lunge	Quads							
	Bicep Curls	Biceps							
	Leg Curls	Hams							
	Bench Press	Chest							

NB: This work out sheet covers for a period of one week.

Overall Comments

....
....
....

Checked By: ....   Date: ....Signature:................................