The Effect of Short and Long Bouts of Home-based Moderate Intensity Exercises on Cardiorespiratory Fitness among Sedentary Western-Kenya Adults Aged at least 50 Years.

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Publications

There has been three publications from this work so far, thus:

1. Magutah K, Patel NB, Thairu K (2016) Majority of Elderly Sedentary Kenyans Show Unfavorable Body Composition and Cardio-Metabolic Fitness. *J Aging Sci* 4: 160. doi:10.4172/2329-8847.1000160.

   (Thesis Chapters 1-5).

2. Magutah K, Meiring R, Patel NB, Thairu K. Effect of short and long moderate-intensity exercises in modifying cardiometabolic markers in sedentary Kenyans aged 50 years and above. *BMJ Open Sport & Exercise Medicine* 2018;4:e000316. doi:10.1136/bmjsem-2017-000316 .

   (Thesis Chapters 1-5).

3. Magutah K, Patel NB, Thairu K. Effect of Moderate Intensity Exercise Bouts Lasting <10 Minutes on Body Composition in Sedentary Kenyan Adults Aged Ó50 Years. *BMJ Open Sport & Exercise Medicine* 2018;4:e000403. doi: 10.1136/bmjsem-2018-000403.

   (Thesis Chapters 1-5).

Abstract

Background: Sedentary lifestyle has recently risen despite existence of exercise recommendations for all age categories. A concurrent increase in morbidities associated with inactivity has also been noted especially amongst older adults. It is possible existing guidelines lack appeal among the older populace.

Goal: To identify a more appealing regime yet with similar CRF benefits as currently recommended regimes.

Objective: The objective was to measure CRF and adherence rates in sedentary adults treating with different exercise regimens over 6 months.

Methodology: 53 sedentary adults at recruitment, were studied over a period of 24 weeks. Randomization was done based on sex and marital status thus: 1) short-bouts exercise males (M_S) (n = 14) and 2) females (F_S) (n = 13), and 3) long-bouts exercise males (M_L) (n = 13) and 4) females (F_L) (n = 13). Short bouts regime comprised <10 minutes moderate intensity exercise per session; long bouts being similar intensity sessions each Ó 30 minutes. Cumulative exercise times were similar. Baseline and 8-weekly body mass index, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), body fat percentage, lipid profiles, fasting blood sugar (FBS), blood pressure, and maximal oxygen consumption ($\dot{V}O_{2max}$) data was collected. Data were analyzed using STATA v.13 in to percentages, means and standard deviations. Further, t-tests were performed based on participantsô regime and sex, and repeated measures analysis of variance conducted for equality of means for paired samples. Regressions were also performed.

Results: Males (n = 27) aged 55.5 ± 3.0 years, females (n = 26) 53.9 ± 3.0 years. All M_S and F_S completed their follow-up compared to 61.5% for M_L and 76.9% for F_L. At baseline, 14.3% M_S and 30.5% M_L were obese, and reduced to 7.1% and 25% respectively by 24^{th} week. Similarly, while 92.3% F_S and 69.2% F_L were obese at baseline, they dropped to 61.6% and 40% respectively. $\dot{V}O_{2max}$ increased in all groups by 24^{th} week, with no difference ($p > 0.05$) between intra-gender groups. BP and HR dropped similarly within sex groups. M_S with WHtR >0.5 dropped to 22.2% from 33% compared to 14.8% from 37% for M_L, while F_S dropped from 50% to 46.2% against 42.3% to 23.1% for F_L. M_S whose baseline WHR was Ó0.9 dropped to 18.5% from 37%, against M_L drop from 40.7% to 11.1%. F_S with WHR Ó0.85 dropped from 23.1% to 11.5% compared to 15.4% to 3.8% for F_L. For high density lipoproteins (HDL) < 0.9 mmol/l at baseline, all M_S and F_S improve to Ó0.9 mmol/l, while M_L and F_L had varied outcomes. M_S and F_S with total cholesterol to HDL ratio (TC/HDL) > 5.0 and 4.5 were 22.2% (µ 6.58±1.21) and 19.2% (µ 5.38±0.92) at baseline, dropping to 7.4% (µ 5.59±0.36) and 7.7% (µ 5.14±0.03) respectively. For M_L and F_L, TC/HDL dropped from 22.2% (µ 6.63±1.29) and 19.2% (µ 5.42±0.59) to 15.4% (µ 5.66±0.5) and 3.8% (µ 5.18±0) respectively. Similar percentage drops were observed for participants with FBS Ó5.5 mmol/l at baseline in all groups.

Conclusion: Short bouts of moderate intensity exercise produce improvement in CRF similar to that seen for long bouts in elderly adults, and have higher compliance.

Recommendations: Short-intermittent regimes of moderate intensity exercise should be recommended for previously sedentary adults just as the longer exercise regime is currently recommended to improve CRF and other metabolic markers.

Declaration

This thesis is my original work presented to University of Nairobi as a partial requirement for the award of a PhD in Medical Physiology.

Karani Magutah

Signatureé é é é é é é é é é .. Dateé é é é é é é é é é é

This thesis has been submitted with our approval as the supervisors:

Supervisors;

Prof Nilesh Patel (PhD)

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Prof Kihumbu Thairu (PhD)

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Dedication

I dedicate this work to my wife Njeri and children Waithera and Magutah. You all have given me reason to soldier on even when multiple times it felt tough enough to go the easier way, give up!.

List of Tables and Figures

List of Abbreviations and Acronyms

ACSM	American College of Sports Medicine
BD	Body density
BMI	Body mass index
BP	Blood pressure
CARTA	Consortium for Advanced Research Training in Africa
CD	compact disk
DBP	Diastolic blood pressure
CRF	Cardio-respiratory fitness
FBS	Fasting blood sugar (glucose)
GPAQ	Global Physical Activity Questionnaire
HDL	High density lipoproteins
HR (PR)	Heart rate (Pulse rate)
IREC	Institutional Research Ethics Committee
LDL	Low density lipoproteins
LTPA	Leisure time physical activity
MET	Metabolic equivalent
MTRH	Moi Teaching and Referral Hospital
MU	Moi University
MANOVA	Multivariate analysis of variance

NCDs	Non-communicable diseases
PA	Physical activity
PAGAC	Physical Activity Guidelines Advisory Committee
PF	Physical fitness
PP	Pulse pressure
RCT	Randomized controlled trial
RM ANOVA	Repeated Measures Analysis of Variance
SBP	Systolic blood pressure
SD	Standard deviation
SRT	Shuttle run test
TC	Total cholesterols
TG	Triglycerides
$\dot{V}O_{2max}$	Maximal oxygen uptake/consumption
WHO	World Health Organization
WHtR	Waist-Height ratio
WHR	Waist-Hip ratio

Operational Definitions

Sedentary behaviour:	Behaviors that involve sitting and low levels of energy expenditure among adults of 50 years and above that amount to less than 1.5 METs (multiples of the basal metabolic rate/metabolic equivalents). Individuals with resultant less than 600 MET-mins per week using the WHO GPAQ analysis guide available at http://www.who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf.
Physical activity:	Any body movement produced by skeletal muscles of adults aged at least 50 years that results in energy expenditure above the basal metabolism.
Physical fitness:	A health level where adults of 50 years and above portray muscular endurance, strength, flexibility and cardiovascular endurance upon exertion.
Cardio-respiratory fitness:	Cardio-respiratory systemsô endurance upon exertion involving skeletal muscles and energy expenditure in males and females of 50 years and above.
Elderly:	50 years or older.
Home-based exercises:	Exercises performed by the 50-year old participants from the confines of their usual dwellings (home compounds) or within their estates of residence.
MET:	A ratio expression defined as the energy expenditure for an adult of 50 years and above sitting quietly, and corresponds to consumption of approximately 3.5 ml of oxygen per kilogram of their body weight per minute.

MET-minutes: Expression of PA intensity as the ratio of an Ó50 years old person's working metabolic rate relative to the resting metabolic rate (while seated) , and so the cumulative time in minutes spent in each of these activities yield the MET-minutes for that individual.

Moderate Intensity exercise: By use of WHO-GPAQ this is estimated by consideration that compared to sitting quietly, an adult of 50 years and above will have a caloric consumption that is four times as high when being moderately active.

Vigorous intensity exercise: When caloric consumption is eight times as high (vigorously active) in an individual of at least 50 years compared to their resting average energy expenditure.

Traditional/continuous exercise bout/session: Exercise session performed by individuals of 50 years and above that last between 30 and 60 continuous minutes.

Short bouts/sessions exercise: Intermittent exercise sessions performed by adults of ages Ó 50 years, that last anything less than 10 minutes, and which sessions may be performed several times a day.

Chapter One

Introduction

The ability of the human body to adjust and maintain supply of oxygen to the various body parts and tissues following exertion, usually referred to as cardio-respiratory fitness (CRF) in medical physiology, is a key area in understanding and controlling many non-communicable diseases. Its benefits help reduce disease risk. It is a measurable health indicator and improves in a graded manner with level of exercise or physical activity participation [1-5].

Sedentary lifestyles are currently on the rise, and inactivity has been observed in both rural and urban set-ups locally [6-9]. Recently, it was found that upwards of 82% of elderly Kenyans from Eldoret, the setting of the current study, do not participate in exercise or physical activity (PA) as recommended for health [10]. This is associated with a rise in related health problems [11, 12]. Understandably, the elderly population has not been spared and there is now an increase in morbidities associated with CRF deficits amongst this group in Kenya and globally [13, 14]. Evidence that participation in exercise or physical activity improves CRF is available however, although data amongst the elderly is still scanty. The World Health Organization (WHO) for instance has recommended exercise regimes for different age categories but adherence to these recommendations is a challenge [12].

Among existing recommendations is moderate intensity exercises performed in bouts of 30-60 minutes for 3-5 days a week [12]. This is exercise at an intensity where heart rate is 50-70% of maximal heart rate usually given as 220 ï (minus) age in years, or where an individual can talk while jogging but not sing [15]. Exercise at this intensity compared to vigorous intensity has still lacked appeal, especially if not supervised [16, 17]. Debate on whether different regime under same moderate intensity would appeal more yet achieve similar good health outcomes has been on for long and still remains unresolved, especially in the elderly [12, 18-24]. This gap should be filled.

To bridge this gap, an investigation of different exercise regimes at similar intensity - moderate intensity - among older adults is timely. This will not only help identify more appealing regimes but also contribute in the debate of the role short bouts have in CRF amongst the older individuals.

Statement of the Problem:

Sedentary lifestyles and inactivity is on the rise. This may be due to the recent observation of rapid urbanization, and has been associated with the concurrent increase in non-communicable diseases (NCDs), a phenomenon in both Kenya and globally today [6-9, 14, 25-27].

If this problem of sedentariness and inactivity which leads to lifestyle diseases is not addressed, the health care system will soon be heavily undermined by the double burden of disease since communicable diseases continue to affect this same population. This is especially expressed among the older individuals [14, 26-31].

There is evidence however that exercise and participation in PA improves CRF for all individuals [1-3, 32-39]. However, exercise adherence is low and high attrition is documented especially amongst the elderly individuals put on exercise prescription [23, 40]. This has not been solved by identifying moderate intensity exercise regimes as having better adherence to vigorous intensity yet with good CRF effects amongst this age category [41-43]. Since overall adherence to exercise remains a mirage, more needs to be done to identify what moderate intensity regimes would work for the older individuals if the rise in lifestyle related NCDs will be mitigated.

The debate on the value and effectiveness of different exercise regimes that would have would have solved this by improving appeal/adherence yet achieve similar benefits to the traditional longer regimes is unsettled. It is unclear how ñshortò bouts lasting less than 10 minutes, more likely to suit the elderly, and performed for a longer time period would contribute to their CRF improvement. Currently, the only study on effect of less than 10 minutesô exercise bouts followed subjects for only 8 weeks and recommended the need for longer-follow-up studies to evaluate the benefits if any among the elderly population [24].

To date, even the WHO, Physical Activity Guidelines Advisory Committee (PAGAC) and American College of Sports Medicine (ACSM) ï the three main bodies mandated with providing guidelines for PA and exercise in their own capacities - are unclear on how best to overcome adherence issues especially among the elderly, who are more likely to have higher exercise attrition rates. This necessitates an evaluation of different moderate intensity exercise bouts that would be more appealing to the elderly populace and, further, yield the best adherence and CRF outcomes.

Significance of the Study:

The findings of this study will be of great benefit to the elderly individuals who are more prone to lifestyle-related NCDs in that more exercise options with documented benefits will be suggested, in addition to the existing guidelines. The findings will be available for policy development as a first in data available from this population in Kenya, at a time NCDs are on the rise. The study will also impact on health care practitioners specifically those prescribing exercise for their older patients by proposing more appealing regimes they could select from.

Assumptions of the Study:

Assumptions in this study included that participants wore their activity monitors as taught and that they did not share them with others at home, affecting quality of data. It was also presumed that none of the participants took any of the prescription drugs described in the exclusion criteria in the course of the study follow-up, or was started on any blood pressure, blood glucose or lipid control drugs.

Hypothesis:

Null hypothesis

Sedentary adultsô(Ó50 years) prescribed exercise to be done or performed in accumulated shorter bouts (<10 min) will achieve the same level of improvement in fitness and adherence as the traditional longer exercise regimes (Ó 30 min) in their normally recommended pattern.

Alternative hypothesis

Sedentary adultsô (Ó 50 years) prescribed exercise done or performed in accumulated shorter bouts (<10 min) does not achieve the same level of improved fitness and adherence as the traditional longer regimes (Ó30 min) in their normally recommended pattern.

Objectives:

Main objective

To determine the CRF improvement and adherence rates from 6 months of two different exercise regimens among sedentary adults aged Ó50 years.

Specific objectives

1. To compare (equipoise) which home-based exercise regimen (short versus long duration bouts) has the least attrition over 6 months of involvement.

2. To estimate the maximal oxygen consumption changes produced by the two different home-based exercise regimes conducted over a period of six months.

3. To examine the effect of the two different home-based exercise regimes on cardiovascular function by measuring blood pressure and heart rate over six months.

4. To test the effect of two six months of home-based exercise regimes on body composition parameters of body mass index, waist-hip ratio, waist-height ratio and body fat percentage.

5. To compare the effect of six months of different home-based exercise regimes on blood lipids and blood glucose metabolic markers.

Chapter Two

Literature review.

This chapter compiles scientific works on CRF, its identified benefits, available methods for assessing physical activity and CRF, current inactivity data, and the ongoing debate on short and long-bout regimes of moderate intensity exercise.

Introduction on Cardiorespiratory fitness:

Cardio-respiratory fitness is the ability of the body to maintain its supply of oxygen during sustained PA [5]. It is a component of the whole concept of physical fitness (PF) which involves a set of attributes people have or achieve, that include those related to health and those pertaining to sports activities, that help them carry out daily tasks with ease [44]. Measurable components related to health include CRF and muscular endurance. In particular, CRF is attained by having optimal performance of the circulatory, respiratory and muscular systems, thus making CRF a crucial component of PF and a key health indicator across all ages and sexes [3, 5, 45]. There are several physiologic measures of CRF including: Maximal oxygen uptake/consumption ($\dot{V}O_{2max}$) - the gold standard in CRF assessment, normalization of blood pressure (BP) and assessment of effects on body mass index (BMI) [46-48]. These CRF measurements are best studied following physical exertion in endurance exercise tests such as the laboratory based treadmill tests, or the field tests such as the shuttle run tests (SRT).

Cardio-respiratory fitness is a sensitive and reliable health indicator useful for habitual PA measurement [3, 5, 45, 49-51]. When in lower values, it is associated with higher morbidity and causes of deaths for both men and women of all ages [33, 52-54]. However, studies have demonstrated a doseï response relationship between PA and improvement in CRF, so that increasing either intensity or volume of PA improves values of the various markers of CRF [1-3, 6-8, 32]. This is useful in improving health of populations.

Benefits of CRF.

A moderate to high level of CRF reduces risk for cardiovascular disease deaths in both men and women [32, 49, 51, 55-57]. The protective effect of CRF on causes of deaths is independent of bio-demographic characteristics of individuals and their behaviours. However, it is assumed that prevalence of low CRF is unevenly distributed among different age groups in the general population, with the elderly populations most affected. An association between sedentariness, overweight and obesity has also been demonstrated over time, with suggestions that this is associated with causes of death and morbidities such as type 2 diabetes and metabolic dysfunction [11, 58]. Participation in regular aerobic PA, however, increases exercise capacity and PF, leading to the various CRF benefits.

Maintenance of lipid profiles, regulation of BP and control of existing cardiovascular ailments are additional health benefits associated with PA and CRF [57, 59-61]. High peak $\dot{V}O_{2max}$ and higher involvement in leisure time physical activity (LTPA) are both linked to reduced cardiovascular morbidity and mortality [61]. It has also been shown that high CRF is associated with favourable metabolic risk profiles, the absence of conglomeration of cardiovascular and diabetes risk factors among all ages, and may actually resolve metabolic syndrome amongst the older adults [30, 32, 57, 62-64].

Recently, the prevalence of metabolic syndrome has been reported to be on the rise in adult populations, which is thought to be associated with their increased sedentariness [11]. How much PA is needed to prevent this remains vague, especially given the suggestions that exercise training started only later in life for individuals who have previously been largely sedentary may lack some of these benefits [65].

PA Assessment.

Studying CRF often requires assessment of PA in an individual, and their endurance to different levels of PA. Unlike factors such as an individualôs genetic make-up, PA is one of the more easily measurable determinants of fitness. Since individuals with high levels of PA and exercise participation are known to improve their CRF to higher levels, such an assessment of PA would also further help to determine the exact effective contribution of the different interventions and exercise prescriptions to CRF and the health of individuals. The ACSM, WHO and PAGAC have published standard protocols applicable in exercise testing. Such standards have included test modes applicable for the different ages of the general population, procedures for each of these protocols, criteria for termination of each of the tests, and the expected normative values for CRF between sex and across age using different methods for different set-ups [5, 12, 66].

Individual studies have also developed recommendations on exercise testing and applications on CRF [67-69]. Some of these PA assessment methods are more objective than others, and include monitoring of actual activity (by use of activity monitors such as accelerometers) and the measurement of heart rate (HR) during activity. When PA and fitness is accurately quantified, health outcomes and effectiveness of intervention programmes become easier to determine [46].

To this end, three broad types of PA assessment methods have been developed, namely: the subjective methods, objective methods, and the criterion methods.

Subjective Methods:

Subjective methods use questionnaires and keeping a diary of PA. They are the weakest of all available techniques of PA assessment, because self-reported PA is subject to recall challenges and to misclassification by subjects [46, 70-72]. This necessitates the employment of higher-rank methods of PA assessment. Such proxy measures are more objective [46].

Objective Methods:

These methods are less biased than the subjective approaches, and have the added advantage of measuring actual exercise intensity. They use electronic activity monitors that can be fastened on a subject to continuously register activity volumes and patterns, without necessarily having the investigator continuously follow the study participant. The devices include use of accelerometers, which have capacity to continuously record HR and therefore show activity patterns [46]. Being electronic motion sensors, they provide continuous information on body posture and activity allowing objective assessment of subjectsô activity and exercise participation, hence fitness levels estimations. Accelerometers do this by evoking a charge when deformed in special directions, such that the magnitude of the resulting voltage is directly related to the extension of the deformation and therefore measuring the related activity. They are mainly worn at the chest level and could be coupled to HR monitors so that other than detecting parameters associated with the mechanical PA of the body, the combination could also provide a minute-to-minute HR changes. Higher HR is associated with greater energy expenditure [46, 73, 74].

Criterion Methods:

These measures are the highest ranking in the estimation of fitness [46, 70, 75]. They involve the investigator remaining with the study participants as measurements are being taken. Among them is the direct laboratory based doubly labelled water calorimetry, which is the gold standard in total energy expenditure and $\dot{V}O_{2max}$ estimation. Doubly-labelled water method involves orally loading a subject with water containing stable isotopes of Deuterium (^{2}H) and ^{18}O, and observing the differences in elimination rates of both ^{2}H and ^{18}O which gives an estimate of carbon dioxide production [76] associated with the aerobic exertions involved. Thus, it is a direct calorimetry method. Other criterion methods include the indirect calorimetry from tests such as treadmills or directly observed field tests such as the shuttle run tests.

While doubly-labelled water calorimetry, the highest ranking direct method is the most reliable and valid measurement for energy expenditure, thus prompting all others to be validated through it, [46], it is expensive and therefore not readily accessible and applicable. Furthermore, it is time consuming, requires highly trained technicians, and is challenging to use with large groups. These drawbacks are shared with the other laboratory tests such as use of a cycle ergometer or a treadmill, which have further challenges being the need for subjects to get accustomed before being tested on them [5, 46]. These drawbacks limit the applicability of these tests especially in resource constrained set ups and among elderly-sedentary subjects, necessitating use of the more accessible and intuitively appealing alternatives.

The Shuttle Run Test Protocol as a Method of Estimating CRF.

A variety of the less expensive but more practicable alternatives that involve energy expenditure and that could estimate fitness include the use of a 20 meter shuttle run test (20 M SRT). Changes in HR, BP, lactate levels and indirectly estimated $\dot{V}O_{2max}$ (the gold standard in the assessment of CRF following exertion exercises and the single most important physiological factor in physical work and fitness determination under aerobic conditions) can thus be estimated [46]. The SRT is a field based non-invasive fitness test whose measurements are based on the highest level attained in the protocol (see appendix 5). It was designed and validated to be done on flat indoor surfaces using workloads (speeds) lasting approximately one minute in each of its 21 levels [77]. It is an accurate multi-stage test of cardiovascular fitness and $\dot{V}O_{2max}$ estimation by exercise intensity applications.

The SRT involves stage-wise progressions that utilize pre-recorded sound signals to direct running speeds, usually spanning from 8.0 km/h at level one to a maximum of 18.5 km/h at level 21. This progression is achieved by decreasing the interval between the sound beeps, thus increasing the running speed by about 0.5 km/h every minute. The incremental nature of the test demands ensure a gradual increase in work rate and thus the exercise intensity. Subjects run to exhaustion while maintaining cadence, i.e. reaching the end of the 20 m course in unison with the tape signal. Equipment used include a pre-recorded audiotape or CD which plays beeps at set intervals, cones placed 20 m from each other, and recording sheets. Subjects continuously run this 20 m distance in time dictated by the recorded beeps, and are only discontinued from the protocol if they fail to reach the stipulated cones at the respective beeps twice in a row, or if they cite exhaustion. If they reach the cones before the beep sounds, they must wait until they hear the expected subsequent sound. Scoring is based on the level of the SRT protocol (Appendix 5) reached, from which the Ramsbottom beep score calculator is employed [78].

The SRT has been concluded as a valid proxy for CRF measurements and is sufficiently reliable in healthy adults. It has for instance been demonstrated to give $\dot{V}O_{2max}$ values at a correlation of above $r = 0.95$ ($P < 0.001$) when compared to treadmill tests [79]. It is therefore more suitable for use in resource-constrained setups found in developing countries and for use with the elderly subjects.

Physical Inactivity on the Rise.

Physical inactivity is currently on the rise, and stands as the fourth leading risk factor for mortality globally [12]. In Sub-Saharan Africa, this has coincided with a rapid urbanization and adoption of more sedentary lifestyles in the aging population, and a concomitant epidemiologic transition of an increase in cardiovascular disease [6, 7, 14, 25, 26]. This is now known as the new epidemic in the region, and, is also found in Kenya [6, 13, 14]. Unchecked, the prevalence of physical inactivity may lead in the long term to poor health in individuals. The simultaneous problem of NCDs is also currently on the rise, and this rise expected to continue. In fact, it is expected that health care systems will be undermined by the double burden of NCD and communicable diseases, as they affect the same population [14, 26, 29-31], unless corrective measures are taken.

Careful consideration of lifestyle protocols may avert the likely mortality associated with rising prevalence of physical inactivity and cardiovascular disease. Scientific evidence on the value of regular PA is clearly documented, and it is established that exercise and PA improves CRF for individuals [1-3, 32-39]. However, most studies from which advice and inference to the general population are drawn, however, concentrate on the younger ages [1, 12, 47]. This is despite the evidence that aging is associated with specific adverse effects on the cardiovascular system that result in ventricular and blood vessels stiffening and atrophy, which affect the ejection fraction and may thus compromise the cardiac output and CRF [45, 65, 80-82]. The specific changes unique to the elderly coupled to a decline in exercise/PA capacities associated with aging, such that poorer countries like Kenya today have more than 4 in every 5 adults as sedentary [6, 8, 10, 12] call for specific physical activity plans that are of lower absolute intensity and would be appealing enough to increase exercise/PA adherence in the elderly group. This has led to the debate on intermittent and accumulated exercise versus continuous bouts in order to reduce physical inactivity and motivate regular physical activity.

Current Debate on Short versus Continuous Exercise Regimes.

The WHO currently recommends that every adult aged above 18 years should achieve a minimum of 150 minutes of moderate-intensity aerobic exercise or at least 75 minutes of vigorous intensity PA weekly (World Health Organization 2010). Previously, this has mainly been through the traditional approach of participation in exercise interventions lasting 30 to 60 minutes for three to five days a week. The challenge of this structured approach, however, has been that of low adherence especially amongst the elderly subjects. A range of 51% to 79% of adults as found from data across the globe do not meet the existing recommendations for PA. Lack of time given other engagements, also associated with age, further reduces PA [12, 83, 84]. To overcome this, both the WHO and PAGAC as well as several studies have recently recommended experimental studies with a global appeal on the benefits, type, intensity, frequency and duration of PA that would advise policy-makers involved at development of PA/exercise guidelines for all ages [12, 66, 85-87].

The value of different exercise regimes and patterns still attract much controversy. Since the ground-breaking work of DeBusk et al (1990), cumulative bouts of exercise were proposed as effective as a single continuous session as long as the cumulative time-lengths were equal. However, debate on the value and effectiveness of short exercise bouts still continues. LaFontaine and Robbins (1991) were the first to counter these conclusions, querying the methods employed, and the latest studies available have yet to settle the debate. Though looking realistic and appealing, data on the efficacy of short sessions has been scarce, probably the reason why WHO, when recently recommending accumulation of exercise bouts lasting at least 10 minutes, cautioned that there is need for more experimental research to confirm its efficacy [12].

It is noteworthy that both WHO and PAGAC are silent on whether such recommended bouts need to be equal or performed in any regulated basis. Thus, although the debate on value of exercise in active elderly individuals is settled and a strong linkage of the benefits of PA/exercise on CRF established [3, 32, 34, 88, 89], the exercise regime to advocate that confers better adherence and fitness outcomes still remains to be determined.

Recently, the debate has attracted more dissenting voices on what exact approaches should be employed in either continuous (long) or short bouts exercise patterns. In fact while a few studies [20, 21] promoted the proposal of short-accumulated bouts as advanced by DeBusk et al (1990), more recent works caution the manner such conclusions were reached, and the methods employed. Murphy et al (2009) argue that further work must be done to determine if even shorter bouts lasting less than 10 minutes would have accumulated value to match traditional approaches of longer/continuous sessions. Linke et al (2011), on the other hand, maintain the need to examine intermittent exercise programs that deviate from the traditional long-sustained exercise regimes especially in the quest to enhance adherence. Further, Macfarlane et al (2006) contend that studies that take longer than the 8 weeks must be adopted to make more intuitive conclusions on the value of less than 10 minutesô bouts compared to the long/continuous bouts of PA since most of the available works have rarely followed individuals beyond 8 weeks of prescribed exercise.

Further arguments have been put forward that while accumulated short bouts of moderate intensity PA/exercise that attain more than 150 minutes of involvement weekly may actually confer benefits such as effectual weight control, benefits in CRF are yet to be observed [90]. Few studies have attempted to evaluate effect of supervised PA/exercise on the more elderly individuals and those that do give conflicting results on the effect of PA in certain of participantsô cardiac performance parameters [45, 65, 91, 92], hence the need for more studies especially amongst the sedentary to resolve this issue.

Thus, there is need to improve the adherence and reduce the attrition associated with exercises protocols recommended for the elderly, to help them achieve positive benefits of exercise. This calls for more work in this area, to confer better understanding of exercise prescription necessary for the elderly. In fact, Thompson et al put it more bluntly that ñconfusion and conflict exists in the assessment of PA in individualsò [93] which could be contributing to the ongoing debate and therefore the need for more studies.

An approach with a careful consideration of methods and time-length would probably settle concerns on whether to continue recommending the structured exercise model of a long-continuous bout of at least 30-60 minutes conducted 3-5 times a week or to promote identified multiple shorter bouts that may help overcome the challenge of a lack of time as a barrier to exercising in individuals faced with the challenge of putting aside a continuous exercise time slot in their busy schedules, or who, by virtue of age, are unable to sustain a continuous physical exertion for long sessions [22, 83]. Further, data on effect of exercise bouts lasting less than 10 minutes, which would be more appealing and realistic for the elderly populace needs to be collected. This would provide evidence for more friendly approaches to exercise among the elderly without having to merely stick to the traditional patterns. Currently, only Macfarlane et al (2006) seem to have studied subjects participating in regimes shorter than 10 minutes, but their follow-up study took only 8 weeks, necessitating their recommendation for considerations that assess the effect of maintaining the very short pattern of exercise for a longer-term.

Study aim.

Data collected will advance approaches in primary and secondary prevention of lifestyle diseases amongst the aging in Kenya by identifying exercise routines that have the best adherence and least attrition, yet are acceptable, applicable and yielding the highest CRF values for the elderly. This will be achieved by a randomized control trial (RCT) that will involve follow-up of subjects on different exercise routines and incorporate an SRT and other evaluation approaches for cardiovascular health at the evaluation stage, as an equivalence trial on whether short bout (< 10 minutes) exercise regimes are at least as good as the traditional long bout (Ó 30 minutes) exercise regimes. Further, our results will contribute to the current debate on the value of intermittent short bouts of moderate exercise over the traditional continuous exercise bouts among the elderly, a group known to have low adherence to exercise prescriptions.

CHAPTER THREE

Methodology:

The chapter discusses where and how the study was set, how participants were selected and how the protocols pertaining the study were carried out. It further describes each of the measurements undertaken and how data were analyzed. It culminates with a description of ethical considerations for participants studied.

Study site:

The study was conducted in Eldoret town of Uasin Gishu County, Kenya. Eldoret is the 5th largest urban area in Kenya and the largest in the North Western Kenya. The town is at 2100 metres above sea level and its geographic coordinates are 0.51° N, 35.27° E. It is composed of a cosmopolitan population estimated to be 345,359 in the 2009 census [94], and is well known for its numerous long distance runners and world class athletes.

Study population:

The study population comprised sedentary males and females aged 50 years and above, living within Eldoret urban and peri-urban areas. Sedentary individuals were identified as those not meeting the 600 MET-minutes per week threshold using the WHO Global Physical Activity Questionnaire (GPAQ) and its show-card analysis (see appendix 6). It was expected that since effects of lifestyle are better demonstrated as an outcome affected by time, a lower cut-off age 50 years would give a clearer distinction of how exercise interventions affects both adherence and CRF measures in previously long-term sedentary individuals.

Study design:

Broadly, this was an experimental study utilizing an RCT approach. Randomization was necessary to reduce selection bias and enhance internal validity in the trial, and was done at individual level by having recruited participants, who had signed informed consent, pick sealed envelopes after individually shuffling them. This reduced confounding that would have arisen from factors such as diet. Stratification for randomization considered participantõs sex and whether they were a married/cohabiting couple. Thus, two sets of the sealed envelopes were specifically provided for males and female, putting them into either of the groups under consideration. The trial groups were balanced with half of each sex for the specific regimes under investigation. Married or cohabiting partners were put in different groups to reduce the effect of diet as a confounder, with assumption they mostly ate the same food at home. The investigator had at the beginning labelled envelopes into either of the two groups, and when participants shuffled and picked them themselves, which automatically assigned them their groups of involvement. Thus, participants were allocated into either a short-duration (< 10 minutes) or the traditional long-duration (Ó 30 minutes) boutsô group as the intervention to be performed between data collection points. This, therefore, yielded 4 groups: (1) Males short-duration bouts of exercise (M_S), (2) Female short-duration bouts of exercise (F_S), (3) Males long-duration bouts of exercise (M_L), and, (4) Female long-duration bouts of exercise (F_L). The design involved collection of baseline data and then at intervals of 8 weeks up to the 24th week. So, 4 sets of data were collected.

Sampling procedure:

Eldoret town of Uasin Gishu was purposively selected for the study. It is the largest-most convenient town in western Kenya where one is most likely to find sedentary individuals. The study was advertised locally by print (Appendix 2) and participants volunteered to take part. Once they matched the inclusion criteria of being 50 years old and above, and also being sedentary as identified using the WHO GPAQ, they were randomly assigned to either a short-durationsôor a continuous-long durationsô bouts of exercise group.

Inclusion criteria: Participants recruited had to be 50 years of age, and confirmed as sedentary using the WHO GPAQ. Further, they had to be healthy and resident within Eldoret town or its environs.

Exclusion criteria: Any cardio-respiratory or any physical ailments/injuries that would compromise participation in exercise.

Sedentary ex-athletes were also excluded since their past activity levels in sports and exercise has been shown to affect their CRF values into their older ages [95-103]. Thus, it was unclear how their inclusion would affect the current study.

Additionally, also excluded were individuals who reported present or recent use of б-blockers and related drugs which are known to reduce peak $\dot{V}O_{2max}$ [104].

Sample size:

This being an equivalence study for comparison of two means ï the short-duration boutsô exercise group versus the traditional-long-duration boutsô exercise group, and with many expected continuous outcome variables, the sample size computation was based on the one outcome variable that had shown (from reviewed literature) the least variability so that it would help yield the largest sample size. Thus, the sample size for each group was computed thus:

$$n = (u + v)^2 (ů_1^2 + ů_0^2) / (ε_0ī\ ε_1)^2$$

Where $ε_0ī\ ε_1$ is the difference between the most commonly measured CRF variable which yielded the largest sample, the $\dot{V}O_{2max,}$ for the short and traditional long bout exercise groups from previous related studies, u is the one-sided percentage point of the normal distribution corresponding to 100% - the power (the desired power is 95%, so, this value is 1.64), v is the percentage point of the normal distribution corresponding to the (two-sided) significance level ï here 1.96, and $ů_1$ and $ů_0$ are the standard deviations associated with the means above as adopted from Macfarlane et al, (2006).

To give maximal difference in these means, highest probable mean $\dot{V}O_{2max}$ (l/min) was used for short bout exercise (mean plus SD), and the lowest probable mean for continuous bout (mean minus SD).

= $(1.64 + 1.96)^2 (0.17^2 + 0.14^2) / (2.65ï\ 2.02)^2$

= 12.96 (0.0289 + 0.0196) / 0.3969

= 15.84

= 16 participants per group before adjustments.

In consideration for loss to follow-up which was anticipated at the beginning of the study, an adjustment factor of 50% loss was employed for this study, so that the actual sample size per group was 16 *1.5, which yielded a sample size of 24 per group. Therefore, since the study had two main cohorts for follow-up, the total sample size arrived at was 48.

Thus, the sample for this protocol was 48 participants, 24 each for each sex and exercise regime type. Given the involving modalities of this follow-up protocol, and the fact that it was a paired sample due to measurements being repeated at four different times for each participant at different times, and also as similar studies have used more or less same sample numbers with reliable results [18, 24, 65, 91, 105], the sample size was considered to be not only sufficient but also unlikely to miss any physiologically meaningful differences associated with the type II error of failing to reject the null hypothesis of similar CRF outcomes for short-sporadic and continuous exercise regime cohorts.

The paired samples were thus expected to yield 192 data points from the four different points of data collection performed.

Data collection:

During the baseline measurements, participantsô bio-demographic characteristics, PA and exercise patterns were initially filled in a form, and their various measurements done by the same investigator throughout. Their height and weight measures were thereafter taken using a stadiometer and a mechanical scale (CAMRY Mechanical scale, BR9012, Shanghai, China), and Body Mass Index (BMI) determined as weight in kilograms divided by height in meters squared. The waist and hip circumferences were also measured using a tape measure, from which waist-to-hip (WHR) and waist-to-height (WHtR) ratios were calculated. Triceps, iliac crest and thigh (for women) and chest, abdominal and thigh (for men) skin fold measures were measured at baseline using the Harpenden Skinfold Caliper (Baty International RH15 9LB, England), and the measurement used for body composition computations.

Participantsôbody fat percentage was estimated using the generalized equations for prediction of body density (BD) for men (BD = 1.10938 - (0.0008267 x sum of chest, abdomen, and thigh skinfolds in mm) + (0.0000016 x square of the sum of chest, abdomen and thigh) - (0.0002574 x age)) and women (BD = 1.0994921 - (0.0009929 x sum of triceps, thigh, and supra iliac skinfolds) + (0.0000023 x square of the sum of triceps, thigh and supra iliac skinfolds) - (0.0001392 x age)) [106-108]. From the BD, Brozek formula, i.e., body fat = (4.57/ɉ ī 4.142) × 100 where ɉ is BD was used to estimate the percentage body fat [109]

Baseline BP measurements were taken using an electronic sphygmomanometer after 5 minutes of rest in a sitting position. Heart rate was also measured at the baseline, and continuously during the incremental speeds of the 20 m SRT that followed, by using a polar HR monitor up to the point of completion of the test or discontinuation as per the test guidelines. Measurements of HR and BP were also taken for the immediate 5 minutes of recovery following the completion of the run test. The level of the SRT reached was used for the estimation of $\dot{V}O_{2max}$ based on the scoring formulae developed by Ramsbottom et al (1988) (Appendix 5).

For all participants, other measurements done at the baseline included blood lipids (Total cholesterols (TC), levels of low and high density lipoproteins (LDL and HDL), and the triglycerides (TG)). These were done using Cobas Integra 400 Plus (Roche, Germany) at the Academic Model Providing Access to Healthcare Reference Laboratories, a certified clinical laboratory run by Indiana University/

Moi University partnership. Fasting blood sugar/glucose (FBS) levels were also measured using Freestyle OptiumÊ glucometer. These were all done before the run test. Four millilitres of venous blood for these measurements was normally taken from the median cubital (basilic) vein around 6-7 am in the morning of the test, following 12 hours of fasting, and the run test conducted in the evening of that same day. For lipid profiles, centrifugation of blood was done within an hour of collection following which the serum was frozen and kept at ï 12°C, awaiting to run accumulated weekly samples together.

Thereafter and for a period of 8 weeks before the next data collection point, participants were put on an exercise/training intervention program that involved either of jogging or fast-walking activities as per intensities and durations shown in the prescription in appendix 4. These are activities that raised HR by between 50-70% of its resting value, one of the criteria for absolute moderate intensity. Other exercise and physical activities that related and fitted this category and intensity as per the GPAQ showcards were also considered (appendix 6), although participants had minimal indulgence in them. This enhanced uniformity of intervention.

Participants had a checklist where they indicated how they adhered to the guiding protocols (see appendices 4a and 4b), and which was analysed with weekly MET-minutes to ascertain PA according to the WHO GPAQ analysis guide, and to ensure participants from different regimes had comparable cumulative exercise extents. This analysis was done based on participantsô group of involvement. All participants indicated by checking-off what total time they spent in each of their exercise sessions, and this was ascertained for objectivity by use of polar wearlink ActITrainer™ accelerometers (Actigraph, Pensacola, FL, USA). The activity monitors were fastened onto the participants on select days.

The investigator made follow-up reminders through phone calls, text messages and direct contact where possible every week, and, further, analysed filled-up GPAQs weekly to ensure participants were meeting the minimum PA requirements for consideration to remain within the study. Follow-up entailed ensuring traditional continuous exercise groups attained at least 30-60 minutes of moderate exercise in each 3-5 sessions of the week, as required, thus yielding at least 600 MET-minutes. For the short-duration bouts exercise, participants attained 5-10 min of exercise thrice daily. These prescriptions are shown in appendix 4. Thus, the exercise intensity for the short-bout group was equal to the traditional group by ensuring at least equivalent cumulative exercise durations. Given the numbers on follow-up and the available HR monitors, the activity monitors were only used on select days to ascertain achievement of the expected minutes of exercise.

Subsequent measurements were done at two month intervals from the start of the exercise intervention to determine if there were changes in the various dependent variables that describe CRF status. Just like at the baseline, these outcome variables included BP normalization, resting and exertion HR changes, blood lipids alteration, blood glucose levels and estimated $\dot{V}O_{2max}$. Other outcomes of interest included WHR and WHtR, skin fold measures, BMI changes, time length on SRT protocol, adherence to home exercise, and attrition rates associated with the protocols. This proceeded to the end of the 6th month, yielding 4 data points for each participant who completed the trial.

Data management and analysis:

STATA version 13 (College Station, TX: StataCorp LP) was used for analysis. Analyses were performed at the univariate, bivariate and multivariate levels. Summary statistics that yielded means and standard deviations (or standard error of the mean where described) for the various individual dependent variables were done. Analysis of these outcome variables were based on exercise regime and sex of the participant. These bivariate analyses included performance of t-tests intra-gender at specific phases of the experiment, to determine association between their participation in the various regimes and their cardio-respiratory outcomes.

Further, the same outcome variables were analysed controlling for the various predictor variables and potential confounders at the multivariate analysis level, where multiple analysis of variance (MANOVA) and linear regressions were performed. Repeated measures analysis of variance (RM ANOVA) was conducted for equality of means of the various outcome variables of these paired samples from the baseline and throughout the next three phases of the experiment. Such outcome variables included changes in HR, BP and blood chemistry measurements described above.

For all measurements, P value considered for significant differences was set at Ò0.05.

Data were presented as percentages, means and standard deviations (or standard error of the mean where indicated) from the mean, in the form of tables and figures.

Ethical Considerations:

The purpose of the study was explained to each participant before seeking his/her written/signed consent (Appendix 1). No positive identifiers such as names were used but, instead, participants were allocated study numbers only known by them and the investigator. Each participant was informed of his/her right to withdraw at any stage of the study if need arose. Personal information and data collected was kept in confidence and has only been used for the current study purposes. A qualified first aider and a first aid kit remained on standby throughout the protocol. The kit contained adhesive tapes, elastic bandages, sterile gauzes, antiseptic wipes, and splints. This ensured prevention and timely address of any injuries that would have occurred. Further, approval to carry out this study was granted by the Moi Teaching and Referral Hospital (MTRH) / Moi University (MU) Institutional Research Ethics Committee (IREC), as approved study number MTRH-MU IREC 0001242.

CHAPTER FOUR

Results:

This chapter summarizes the findings of the study in prose, tables and figures. After description of study participants and their characteristics at recruitment, the results have been organized into sub-sections based on the objective of the study being addressed.

4.1 Demographic, Body Composition, and Cardio-metabolic Characteristics of Participants at Baseline.

The mean age of the males (n = 27) was 55.5 ± 3.0 years and for the female (n=26), 53.9 ± 3.0 years. A majority of them (88.4% of males and 70.4% of females) had attained tertiary level of education with all the rest reaching secondary level. Ninety one (90.6) percent were currently in diverse white collar jobs, and the remaining 9.4% were retired from the same.

The participantsô body composition was determined using different methods. Using the WHO BMI cluster categorization, for the male and female respectively, 25.9% and 80.8% were obese (BMI Ó30.0), 40.7% and 7.7% were overweight (BMI 25.0-29.9), and the rest (33.3% and 11.5%) were normal weight (BMI 18.5-24.9). Thus, 66.6% of the males and 88.5% of the female had BMI above 24.9 Kg/M^2 at baseline. The WHtR was 0.54 ± 0.07 for the male and 0.58 ± 0.75 for the female, and the percentage of those with a ratio above the 0.5 cut-off was 70.4 and 88.5 for males and female respectively. Waist-to-hip ratios of males and female averaged 0.94 ± 0.06 cm and 0.82 ± 0.11 cm, respectively, with 78% (male) and 38.5% (female) having ratios Ó0.90 and Ó0.85. Body density for the males was 1.05 ± 0.19 and, for females, it was 1.01 ± 0.1. Body fat percentage in males was 22.26 ± 7.95 while that for the female was 38.33 ± 4.69.

The baseline pre-SRT BP Ó140/90 mmHg was measured in 22.2% of males and 23.1% of females. In addition, those with SBP above 140 mmHg but a DBP below 90 mmHg were 14.8% and 15.4% for males and female, respectively. Only one among the male and female had DBP above 90 mmHg but with the SBP below 140 mmHg. The pre- and 5 minutes post SRT BP differences were not statistically significant (SBP: $p = 0.12$ and $p = 0.26$; and, DBP: $p = 0.83$ and $p = 0.32$ for males and females, respectively).

For the blood chemistry parameters, baseline mean FBS levels were 5.92 ± 1.4 mmol/l for males and 6.23 ± 0.74 mmol/l for females. Seventy four (74.1) percent of the males and 88.5% of the females had pre-diabetic to diabetic FBS levels Ó5.5mmol/l. Almost half (48.1% of males and 42.3% of females) had baseline TC levels above the cut-off of 5.2 mmol/l (males) and 5.3 mmol/l (females), respectively. In 29.6% of males and 26.9% of females, LDL values were outside the normal range (1.3-3.9 mmol/l). A similar percentage (29.6%) of males and 23.1% of females had HDL levels < 0.9 mmol/l. For TGs 22.2% of males and 7.7% of females had levels above 2.3 mmol/l. TC/HDL ratios above the 5.0 (males) and 4.5 (females) cut-offs were found in 44.4% of males and 38.5% of females. The mean TC/HDL ratio for males above cut-off was 6.61 ± 1.19 (range 5.23-8.97) and for females it was 5.40 ± 0.73 (range 4.64-6.96). Thirty three percent of males had LDL/HDL values above their 3.5 cut-off (4.47 ± 0.87) and 34.6% of females had LDL/HDL values above the female cut-off of 3 (3.46 ± 0.32). There were 7.4% and 3.8% males and females respectively with TG/HDL above cutoffs of 3.5 (males) and 2.5 (females), and the corresponding means were 4.07 ± 2.01, and 2.78 ± 0.

A summary of the baseline characteristics of the participants based on sex is shown in Table 1.

Table 1: Baseline demographic and clinical characteristics of the participants.

	Male (n=27)	**Female (n=26)**
Age (years)	55.52 ± 3.0	53.88 ± 3.0
BMI (kg/m$^{2)}$	27.13 ± 4.55	32.32 ± 5.07
Waist/Height Ratio	0.54 ± 0.07	0.58 ± 0.75
Waist/Hip Ratio	0.94 ± 0.06	0.82 ± 0.11
Sum of 3 skinfolds (mm)	68.76 ± 30.85	113.81 ± 23.31
Body density	1.05 ± 0.19	1.01 ± 0.1
Fat %	22.26 ± 7.95	38.33 ± 4.69
Pre-exertion Systolic BP (mmHg)	139.81 ± 19.42	135.12 ± 19.83
Pre-exertion Diastolic BP (mmHg)	82.93 ± 9.9	83.77 ± 9.53
Pre-exertion heart rate (b/m)	75.3 ± 8.64	75.77 ± 10.93
Exhaustion Systolic BP (mmHg)	194.04 ± 18.75	189.73 ±2 5.4
Exhaustion Diastolic BP (mmHg)	83.52 ± 9.48	84.42 ± 10.18
Exhaustion heart rate (b/m)	126.44 ± 13.86	124.12 ± 15.38
5 min post-exertion Systolic BP (mmHg)	135.44 ± 15.09	127.73 ± 14.48
5 min post-exertion Diastolic BP (mmHg)	77.37 ± 9.34	75.08 ± 10.49
5 min post-exertion heart rate (b/m)	90.81 ± 10	88.27 ± 9.85
$\dot{V}O_2max$ (ml/kg/min)	25.39 ± 4.44	20.36 ± 1.93
Fasting blood glucose (mmol/l)	5.92 ± 1.4	6.23 ± 0.74
Total Cholesterol (TC) (mmol/l)	5.19 ± 1.52	5.26 ± 1.94
High density lipoproteins (HDL) (mmol/l)	1.18 ± 0.41	1.19 ± 0.34
Low density lipoproteins (LDL) (mmol/l)	3.15 ± 1.05	3.14 ± 1.03
Triglycerides (TG) (mmol/l)	1.81 ± 1.09	1.25 ± 0.76
TC/HDL ratio	4.84 ± 2	4.41 ± 0.97
LDL/HDL ratio	2.96 ± 1.34	2.67 ± 0.69
TG/HDL ratio	1.91 ± 1.69	1.1 ± 0.62

Data presented as means ± standard deviation.

4.2 Attrition Rates for the Different Home-Based Exercise Regimens.

All M_S (n=14) completed the 24-week follow-up protocol compared to 61.5% (n=13) for M_L. Similarly, 100% of F_S (n=13) completed the protocols compared to 76.9% (n=13) for F_L. By the end of the first 8 weeks when the first follow-up visit was done, 23.1% for both M_L and F_L had dropped from the protocol, and this rose to 38.5% for M_L by week 16, with the number of F_L remaining the same. All long-bout participants who reached week 16 completed the entire follow-up at the 24^{th} week.

A total of 69.2% (n=26) of the participants on longer bouts completed the 24-week follow-up. In terms sex of these participants, 55.6% (n=18) were female compared to 44.4% who were male. In terms of education, 66.7% (n=6) of participants with secondary level education on long-bouts dropped out from the protocol before the 24^{th} week compared to 20% (n=20) with tertiary level education. While obese (BMI Ó30.0) individuals, (WHO categorization of BMI) were 52.8% of all the participants, they accounted for 75% of all the drop-outs. In terms of gender, the drop outs among obese participants were 60% (n=5) for males and 33.3% (n=9) for females.

4.3 The Maximal Oxygen Consumption Changes Produced by the Different Home-Based Exercise Regimen.

The $\dot{V}O_{2max}$ measured at baseline rose by the 24^{th} week of follow-up in each of the groups (Fig 1). However, no difference was observed in the $\dot{V}O_{2max}$ between the short and long bouts in each of the four-data points during the follow-up for both male and female on the two exercise regimes (p Ó0.05).

The mean change in $\dot{V}O_{2max}$ between the short and the long boutsôcomparing values from baseline and 24^{th} week (Fig. 2) were different amongst the male (p=0.02) but not in the females. These values and a summary of the time taken on the SRT in each of the visits for both males and females on the different exercise regimes is shown in Table 2 below.

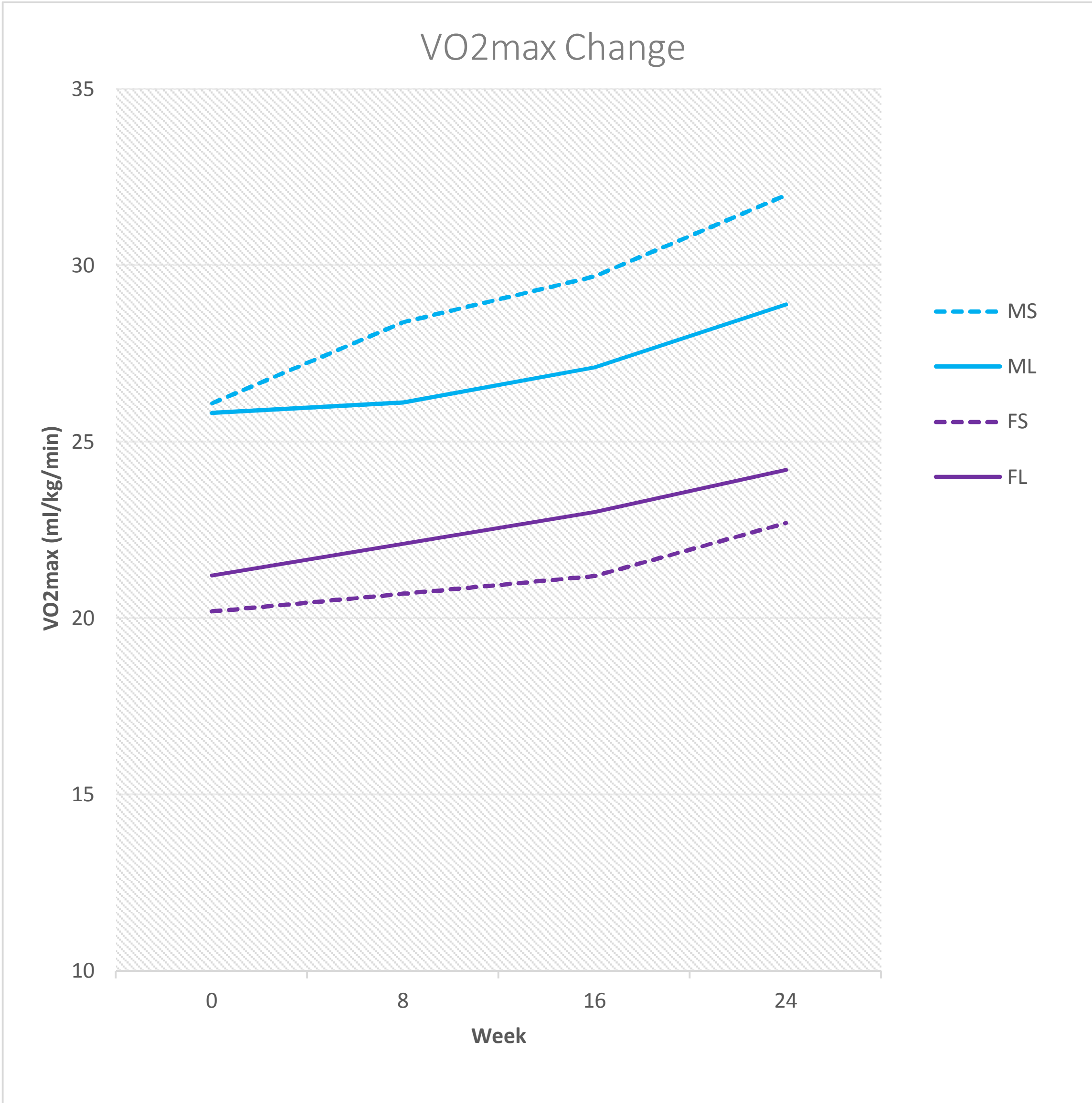

Figure 1: V̇O2max from week 1 to week 24.

Table 2: $\dot{V}O2max$ and time taken on the SRT between baseline and end-point

Variable	Group	Baseline	Week 8	Week 16	Week 24	Mean Change (wk 24 - wk 0)	p Value
Male							
SRT time	Short	189.3±79.1	231.9±101.7	254±109.5	297±113.6	107.71±52.1	
(s)	Long	183.6±93.7	191.8±96.3	208.5±95.3	239.6±101.9	56.0±35.8	0.02
$\dot{V}o_2max$	Short	26.1±4.4	28.4±5.7	29.7±6.0	32.0±6.2	5.88±2.8	
	Long	25.8±5.1	26.1±5.2	27.1±5.2	28.8±5.4	2.96±2.0	0.02
Female							
SRT time	Short	82.9±29.9	90.2±32.4	99.2±35.9	125.5±37.3	42.6±17.1	
(s)	Long	98.6±34	115.6±53.9	131.3±51.8	153.6±50.6	55.0±26.8	0.19
$\dot{V}o_2max$	Short	20.2±1.8	20.7±1.9	21.2±2.1	22.7±2.0	2.51±1.0	
	Long	21.2±1.9	22.1±2.9	23.0±2.8	24.2±2.7	2.98±1.5	0.38

Data in means± standard deviation; paired samples, n=45

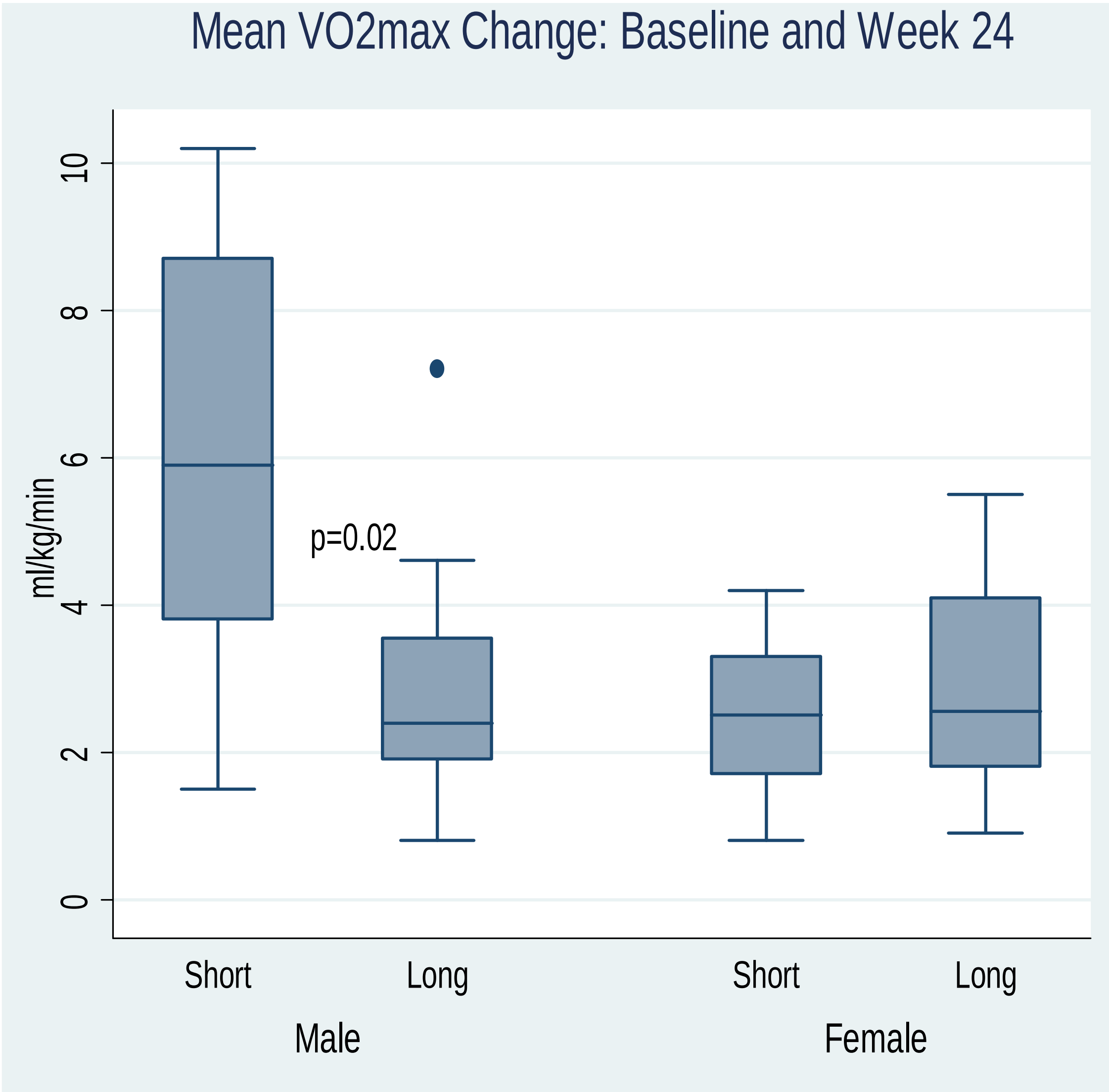

Figure 2: Mean change in $\dot{V}$O2max between baseline (value 0) and the 24th week.

Controlling for sex, regression of the difference in maximal oxygen consumption for the two exercise regimes showed that the two were not different (Table 3).

Table 3: Regression of $\dot{V}O_{2max}$ and SRT for the two regimes based on sex

Mean change, Long	Coefficient	Standard Error	P>|t|	[95% Conf. Interval]	
$\dot{V}O_{2max}$	1.28	1.29	0.33	-1.33	3.89
SRT time	-18.0	12.0	0.14	-42.3	6.27

4.4 Effect of the Different Exercise Regimes on Cardiovascular Function.

A general decrease in BP and HR was observed for individuals in the two exercise regimes over the follow-up period (Table 4). Comparison of the mean change in the different variables between groups based on sex showed no significant differences. Associated pulse pressure (PP) changes for the period (Table 5), also show no statistical difference between the two exercise regimes. In males, however, the short-bouts regime lowered the PP at exhaustion from the SRT much more than did the longer bouts (-15.5 ± 9.6 versus -2.0 ± 13.0; p=0.01) over the 24 weeks.

Table 4: Absolute blood pressure and heart rate changes

Variable (Ratio)	Group	Week 0	Week 8	Week 16	Week 24	Mean φ (wk 24 - wk 0)	p
Male							
Resting SBP	*Short*	138.9±17.4	132.9±15.2	130.6±16.9	122.4±12.5	-16.4±10.7	
	Long	138.6±26.4	131.9±25.1	126.6±15.1	116.5±10.7	-22.1±27.6	0.49
Exhaustion	*Short*	196.3±17.9	194.8±21.8	189.6±21.3	177.5±14.5	-18.8±11.6	
SBP	*Long*	185.9±20.6	183.6±19.6	176.1±13.2	175.6±15.3	-10.3±10.1	0.10
SBP at 5min	*Short*	130.3±9.8	132.1±14.0	129.1±15.0	120.7±8.1	-9.6±10.1-	
	Long	137.6±16.8	131.5±9.1	125.4±12.0	117.9±7.5	19.9±16.5	0.08
Resting DBP	*Short*	82.1±11.3	78.5±10.6	74.0±8.8	71.8±5.8	-10.4±7.8	
	Long	83.0±10.0	80.8±12.7	76.4±8.5	74.0±6.7	-9.0±7.4	0.69
Exhaustion	*Short*	78.7±7.5	80.1±7.1	79.0±8.6	75.4±5.4	-3.3±6.0	
DBP	*Long*	86.8±9.7	84.4±5.6	83.5±5.3	78.5±4.5	-8.3±8.5	0.12
DBP at 5min	*Short*	75.4±9.2	72.5±6.2	71.3±7.2	67.8±4.2	-7.6±7.6	
	Long	77.8±4.9	78.1±3.6	74.1±6.4	73.0±3.8	-4.8±7.2	0.39
Resting HR	*Short*	73.9±9.5	70.0±9.4	66.1±9.9	63.0±7.2	-10.9±8.6	
	Long	74.9±8.3	71.0±6.6	72.0±6.9	64.8±5.7	-10.1±8.1	0.85
Exhaustion	*Short*	125.4±14.4	120.5±17.0	113.6±18.3	118.4±15.4	-6.9±15.5	
HR	*Long*	129.1±14.7	119.8±20.1	125.9±14.9	130.3±16.7	1.1±14.0	0.24
HR at 5min	*Short*	90.8±8.8	85.9±11.0	82.4±7.6	74.9±5.6	-15.9±7.9	
	Long	91.4±13.0	84.0±10.1	81.5±12.5	76.9±7.6	-14.5±10.3	0.73
Female							
Resting SBP	*Short*	133.7±13.2	129.9±15.4	125.5±14.8	118.5±12.8	-15.2±4.1	
	Long	130.5±16.1	126.5±14.5	122.6±15.2	116.4±11.4	-14.1±11.8	0.75
Exhaustion	*Short*	193.0±28.0	182.7±24.0	178.2±25.1	174.7±25.4	-18.3±13.8	
SBP	*Long*	182.0±24.5	178.4±27.8	170.8±15.7	167.2±16.6	-14.8±19.5	0.62
SBP at 5min	*Short*	127.2±11.7	124.2±16.5	124.6±12.2	119.5±14.1	-7.6±8.4	
	Long	122.5±13.2	121.8±14.8	118.5±11.0	114.3±11.0	-8.2±12.2	0.89
Resting DBP	*Short*	83.7±10.6	80.1±11.2	77.2±10.3	73.9±9.0	-9.8±5.5	
	Long	81.8±7.6	75.9±8.6	75.3±7.6	70.8±8.0	-11.0±4.6	0.57
Exhaustion	*Short*	83.3±11.3	84.2±10.2	83.8±11.1	80.5±9.5	-2.8±8.9	
DBP	*Long*	84.4±9.5	81.7±10.6	79.7±7.1	75±6.3	-9.4±8.4	0.08
DBP at 5min	*Short*	74.1±10.8	75.5±10.6	73.6±8.3	70.5±8.2	-3.6±6.1	
	Long	74.6±10.9	74.6±19.9	69.4±8.7	68.1±6.5	-6.5±7.0	0.30
Resting HR	*Short*	79.8±12.0	73.9±12.4	71.7±7.9	66.4±6.5	-13.4±11.3	
	Long	68.2±5.6	68.2±11.4	64.0±7.2	62.8±7.7	-5.4±4.5	0.05
Exhaustion	*Short*	125.2±13.3	123.1±15.8	121.3±19.6	119.8±14.3	-5.4±13.8	
HR	*Long*	122.7±19.1	113.3±17.5	112.6±21.4	116.9±21.5	-5.8±21.3	0.96
HR at 5min	*Short*	91.5±10.3	86.3±6.2	81.7±7.1	75.7±6.9	-15.8±9.3	
	Long	84.2±9.6	81.6±10.1	73.6±6.5	71.3±5.7	-12.9±8.9	0.46

Data in means± standard deviation

Table 5: Pulse pressure changes over the 24 weeks

Variable (Ratio)	Group	Baseline	Week 8	Week 16	Week 24	Mean φ (wk 24 - wk 0)	p
Male							
Resting PP	*Short*	56.7±11.4	54.4±7.5	56.6±11.5	50.6±9.1	-6.1±10.8	
	Long	55.6±17.7	51.1±17.2	50.3±8.7	42.5±7.1	-13.1±22.2	0.32
Exhaustion PP	*Short*	117.6±13.4	114.6±17.6	110.6±16.6	102.1±12.4	-15.5±9.6	
	Long	99.1±21.2	99.3±17.5	92.6±13.6	97.1±16.0	-2.0±13.0	0.01
5-min rest PP	*Short*	54.9±9.7	59.6±12.0	57.8±11.2	53.0±7.3	-1.9±10.2	
	Long	60.0±17.1	53.4±6.6	51.3±7.0	44.9±8.1	-15.1±19.0	0.05
Female							
Resting PP	*Short*	50.0±7.1	49.8±8.4	48.3±6.4	44.5±7.7	-5.5±4.8	
	Long	48.7±14.1	50.6±13.8	47.3±12.1	45.6±9.0	-3.1±12.9	0.55
Exhaustion PP	*Short*	109.7±22.7	98.5±17.7	94.3±17.5	94.2±17.9	-15.5±13.5	
	Long	97.6±26.1	96.7±22.1	91.2±12.0	92.2±12.2	-5.4±23.6	0.20
5-min rest PP	*Short*	53.1±6.7	48.7±9.7	51.0±7.1	49.1±8.1	-4.0±7.4	
	Long	47.9±12.2	47.2±10.8	49.1±8.1	46.2±6.7	-1.7±11.4	0.56

Values are Means +/- standard deviation

4.5 Effect of the Two Home-Based Exercise Regimes on Body Composition.

At the end of the 24th week, 13.6% males (n=27) and 52.2% females (n=26) were obese compared to the 25.9% males and 80.8% females at the start. For the normal weight categories, the number rose to 45.5% (from 33.3%) for males and 21.7% (from 11.5%) for the females. While 14.3% of M_S had started the follow-up as obese, this dropped to 7.1% at the end point compared to a drop from 38.5% to 25% for M_L participants. Similarly, percentage of F_S dropped to 61.6% from 92.3%, with the F_L dropping from 69.2% to 40%.

The percentage of M_S whose WHtR was above 0.5 (n=9) dropped from 33% to 22.2% of all males (n=27) with the mean WHtR dropping from 0.56 ± 0.04 to 0.53 ± 0.02. This compared to a drop from 37% to 14.8% for M_L, and whose mean values equally dropped from 0.59 ± 0.05 to 0.56 ± 0.07. For F_S group (n=13), the percentage of those with values above 0.5 dropped from 50% to 46.2 % of all females (n=26). Their mean WHtR dropped from 0.61 ± 0.05 to 0.56 ± 0.05. Likewise, participants in the F_L group with a WHtR > 0.5 dropped from 42.3% (n=26) to 23.1%, and mean values similarly dropping from 0.59 ± 0.06 to 0.57 ± 0.04.

The WHR was also changed. Males with baseline WHR Ó0.9 drawn in the M_S group were 37% of all males. They had a mean value of 0.95 ± 0.03. Their M_L counterparts accounted for 40.7% and had a mean of 0.96 ± 0.06. At the end of the 24 weeks, the percentages dropped to 18.5% with a mean of 0.92 ± 0.2 for M_S and to 11.1% with a mean value of 0.96 ± 0.06 for M_L. Females with baseline WHR Ó0.85 and participated as F_S group was 23.1% of all females (n=26). Their mean WHR was 0.9 ± 0.05. Their F_L counterparts accounted for 15.4% and had a mean WHR of 0.95 ± 0.02. At completion of the protocol, F_S participants whose WHR remained Ó0.85 dropped by half (11.5%), with mean values also dropping to 0.89 ± 0.04. Their F_L counterparts dropped to 3.8% (n=26), and the WHR dropped to 0.88 ± 0.

Generally, all variables associated with body composition were found to decrease in the measured parameters in both males and females. There was significant drop in body weight, BMI, WHtR, WHR and percentage body fat (all $p < 0.05$). However, the mean change difference for each variable was not significantly different between individuals in the two exercise groups for both sexes (Table 6). Upon controlling for the sex, Table 7 presents a summary of linear regressions for the variables.

Table 6: Body composition measurements

Variable	Group	Baseline	Week 8	Week 16	Week 24	Mean Change (wk 24 - wk 0)	p Value
Male							
Weight	Short	76.4±14.7	75.2±14.5	74.9±14.0	72.3±14.2	-4.07±5.8	
	Long	82.8±16.2	82.3±15.8	81.4±15.3	79.4±15.8	-3.31±3.0	0.74
BMI	Short	25.8±4.0	25.4±4.0	25.3±3.8	24.4±4.0	-1.37±2.0	
	Long	28.2±5.0	27.9±4.6	27.7±4.7	27.0±4.1	-1.13±1.01	0.75
WHtR	Short	0.52±0.07	0.51±0.06	0.50±0.06	0.49±0.05	-0.03±0.02	
	Long	0.55±0.08	0.54±0.09	0.53±0.08	0.51±0.07	-0.04±0.02	0.63
WHR	Short	0.93±0.06	0.92±0.06	0.90±0.05	0.87±0.05	-0.05±0.04	
	Long	0.96±0.08	0.94±0.08	0.91±0.08	0.89±0.07	-0.06±0.03	0.44
Fat%	Short	20.7±7.3	15.6±5.9	14.2±5.5	12.4±4.8	-8.32±5.0	
	Long	21.6±8.5	19.3±7.5	17.3±6.3	15.2±5.8	-6.43±3.8	0.36
Female							
Weight	Short	85.3±13.7	84.2±13.9	83.0±14.1	81.7±13.2	-3.61±1.54	
	Long	78.1±11.0	75.0±9.6	73.9±9.6	72.5±9.9	-5.65±5.53	0.22
BMI	Short	33.3±4.8	32.9±4.8	32.4±4.9	31.9±4.6	-1.41±0.60	
	Long	30.5±5.1	29.3± 4.6	28.9±4.9	28.4±5.1	-2.15±2.13	0.25
WHtR	Short	.605±.049	.573±.054	.565±.049	.557±.050	-0.05±0.02	
	Long	.55±.085	.534±.081	.527±.085	.518±.082	-0.04±0.02	0.21
WHR	Short	.822±.095	.822±.065	.811±.066	.801±.066	-0.02±0.05	
	Long	.803±.078	.794±.085	.783±.081	.785±.079	-0.02±0.04	0.84
Fat%	Short	39.8±3.6	35.0±5.1	32.3±5.3	31.1±5.6	-8.69±4.41	
	Long	35.8±4.4	30.8±4.6	29.3±4.9	27.8±4.9	-7.96±3.34	0.67

Values are Means +/- standard deviation

Table 7: Linear regressions for body composition (controlling for sex)

Mean change, Long	Coefficient	Standard Error	P>|t|	[95% Conf. Interval]	
Weight	-0.71	1.35	0.60	-3.44	2.02
BMI	-0.27	0.49	0.58	-1.25	0.71
WHtR	0.004	0.01	0.53	-0.01	0.09
WHR	-0.004	0.01	0.75	-0.03	0.02
Fat%	1.28	1.29	0.33	-1.33	3.89

Controlling for sex meant that analysis considered effect of the two regimes with sex taking a fixed value (pooled data)

The percentage change in body fat for the two sexes and groups showed a similar drop (Figure 3).

Figure 3: Percentage fat change between week 0 and week 24.

4.6 Effect on Metabolic Markers.

Most of the cardio-metabolic measurementsô values, with the exception of HDL dropped over the experimental period in both males and female of the two exercise groups. A marginal change in LDL and TG values was observed, with M_L and F_L participants having a slight rise in both LDL and TG, but with the associated lipid ratios dropping. The same measurements had mixed outcomes amongst the M_S and F_S groups. For participants whose HDL at the baseline was < 0.9 mmol/l, all participants in M_S and F_S groups attained recommended levels Ó0.9 mmol/l, while their M_L and F_L counterparts had varied outcomes (no change for the males, and 3 in every 4 female attaining Ó0.9 mmol/l). These values have been summarized in Table 8, and the mean change in FBS and the various lipids ratios plotted in Figures 4 and 5. Further, a linear regression summary of these variablesô mean differences controlling for sex is provided in Table 9.

Pooled baseline data described previously had shown 48.1% and 42.3% of males and females, respectively, having TC above their respective normal cut-offs. Disaggregation of this based on the exercise regime adopted had, at the baseline, 22.2% of all males whose TC was unfavorable (above 5.2 mmol/l) put in M_S against 25.9% who were in the M_L group. When the same was done for the female, 30.8% of the female whose values were above the reference cut-off of 5.3 mmol/l ended up in F_S compared to 11.5% who ended up in the F_L. At the end of the trial, the percentage of M_S whose TC remained unfavourable dropped to 14.8% with the mean TC for those remaining above the cut-off equally dropping from 6.4 ± 1.38 mmol/l to 5.48 ± 0.41 mmol/l. Participants in M_L whose TC did not reach the recommended levels equally dropped to 3.7%, and had a mean TC of 5.76mmol/l down from 6.09 ± 0.58 mmol/l. Similarly, the percentage of F_S whose TC remained above 5.3 mmol/l dropped from 30.8% to 11.5% as did the mean value of TC, for those remaining above the threshold, dropping from 6.75 ± 1.46 mmol/l to 5.72 ± 0.15 mmol/l. For F_L, no one had a TC drop to the recommended range although there was notable decrease in the mean values from 7.78 ± 1.79 mmol/l to 5.76 ± 0.44 mmol/l.

For lipid ratios, males and females in the short bouts groups whose TC/HDL was above the 5.0 and 4.5 threshold at the baseline were 22.2% (mean = 6.58 ± 1.21) and 19.2% (mean = 5.38 ± 0.92), respectively. Likewise, similar percentage of 22.2% males (mean = 6.63 ±

1.29) and 19.2% females (mean = 5.42 ± 0.59) were recruited in the long bout groups. At the end of the follow-up period, the percentage of M_S and F_S above their respective cut-offs had dropped to 7.4% (mean = 5.59 ± 0.36) and 7.7% (mean = 5.14 ± 0.03). The percentage for M_L and F_L with TC/HDL > 5.0 and > 4.5 equally dropped to 15.4% (mean = 5.66 ± 0.5) and 3.8% (mean = 5.18 ± 0) respectively.

The trend remained the same when LDL/HDL was considered. The M_S and F_S whose LDL/HDL was above the 3.5 and 3 threshold at the baseline, compared to the end-point, dropped from 14.8% (mean = 4.07 ± 0.53) to 7.4% (mean = 3.61 ± 0.14) and from 23.1% (mean = 3.53 ± 0.27) to 15.4% (mean = 3.49 ± 0.55), respectively. For M_L, the reduction was from an overall 18.5% (mean = 4.79 ± 1) to 11.1% (mean = 4.65 ± 0.67). Among the F_L, the percentage reduction was from 11.5% (mean = 3.32 ± 0.43) to 3.8% (mean = 3.49 ± 0).

A similar picture of improved FBS was observed. While at the baseline, M_S with FBS Ó 5.5 mmol/l were 40.7 % of all males, this dropped to 11.1% at the end of the 24th week, and a similar drop in the mean value for those who remained with FBS Ó5.5 mmol/l was seen, from 6.08 ± 0.48 mmol/l to 5.63 ± 0.15 mmol/l. The percentage of M_L with FBS Ó 5.5 was 33.3% and this dropped to 3.7% after the 24 weeks, with a mean value of 8.2 mmol/l from a baseline mean value of 6.69 ± 2.03 mmol/l. The percentage F_S group with baseline FBS Ó5.5 mmol/l was 46.2% for all females, and their FBS mean was 6.27 ± 0.53 mmol/l. This percentage dropped to zero at the end of the follow-up period. For the F_L, they accounted for 42.3% of all females and dropped to 11.5% with a mean change in FBS from 6.55 ± 0.64 mmol/l to 6 ± 0.44 mmol/l at the end of the protocol.

Table 8: Cardio-metabolic measurements

Variable	Group	Baseline	Week 8	Week 16	Week 24	Mean φ (wk24 ï wk 0)	p
Male							
FBS	*Short*	5.9±0.6	5.5±0.5	5.4±0.9	5.0±0.5	-0.91±0.7	
	Long	6.4±2.4	6.2±1.9	5.8±1.7	4.9±1.4	-1.54±1.1	0.12
TC	*Short*	5.4±1.3	4.8±1.2	4.8±0.9	4.7±0.8	-0.68±1.3	
	Long	5.0±0.8	4.7±1.2	4.8±1.0	4.3±0.7	-0.68±0.5	0.99
HDL	*Short*	1.3±0.5	1.3±0.4	1.5±0.4	1.6±0.4	0.30±0.4	
	Long	1.0±0.3	1.0±0.3	1.1±0.4	1.2±0.5	0.21±0.3	0.55
LDL	*Short*	3.1±0.9	3.1±0.8	2.9±0.9	3.1±0.7	0.04±0.7	
	Long	2.8±1.2	3.2±1.5	2.9±1.2	2.9±1.3	0.13±0.9	0.81
TG	*Short*	1.8±1.3	1.6±0.9	1.7±0.8	1.6±0.5	-0.23±1.2	
	Long	1.9±0.9	2.4±1.8	2.3±0.9	2.1±1.1	0.16±0.8	0.42
TC/HDL	*Short*	4.8±1.9	4.0±1.5	3.6±1.6	3.2±1.3	-1.52±1.4	
	Long	5.4±1.9	5.1±1.9	5.0±1.7	4.1±1.8	-1.24±1.3	0.65
LDL/HDL	*Short*	2.8±1.2	2.6±1.0	2.3±1.3	2.2±0.9	-0.59±0.9	
	Long	3.0±1.5	3.2±1.8	2.9±1.4	2.9±1.7	-0.16±1.0	0.30
TG/HDL	*Short*	1.8±2.0	1.5±1.1	1.4±1.2	1.1±0.6	-0.75±1.6	
	Long	2.2±1.6	3.1±3.7	2.6±2.0	2.2±1.9	-0.04±0.9	0.26
Female							
FBS	*Short*	6.1±0.7	5.5±0.4	5.1±0.2	4.8±0.4	-1.37±0.8	
	Long	6.2±0.9	5.7±0.9	5.5±0.9	4.7±1.1	-1.54±0.8	0.69
TC	*Short*	5.8±1.7	4.9±0.5	5.0±0.8	4.9±0.5	-0.91±1.4	
	Long	4.0±1.0	4.8±0.8	4.7±0.6	4.5±1.2	-0.51±0.9	0.01
HDL	*Short*	1.3±0.3	1.2±0.2	1.4±0.3	1.4±0.3	0.12±0.4	
	Long	1.0±0.3	1.2±0.2	1.3±0.2	1.4±0.3	0.41±0.3	0.07
LDL	*Short*	3.6±0.9	3.5±0.7	3.1±0.9	3.5±0.8	-0.03±0.6	
	Long	2.6±0.9	3.4±0.7	2.8±1.0	3.1±1.0	0.45±0.8	0.11
TG	*Short*	1.3±0.5	1.2±0.4	1.1±0.4	1.3±0.6	-0.04±0.4	
	Long	1.0±0.3	1.2±0.4	1.1±0.3	1.1±0.3	0.19±0.5	0.21
TC/HDL	*Short*	4.5±1.0	4.1±0.8	3.7±0.8	3.6±0.9	-0.88±0.8	
	Long	4.2±0.7	4.0±0.7	3.7±0.6	3.3±0.9	-0.88±0.9	1
LDL/HDL	*Short*	2.8±0.8	2.9±0.8	2.3±0.7	2.5±0.8	-0.23±0.7	
	Long	2.7±0.5	2.8±0.7	2.2±0.8	2.2±0.7	-0.43±0.6	0.45
TG/HDL	*Short*	1.1±0.5	1.0±0.4	0.8±0.3	0.9±0.5	-0.13±0.2	
	Long	1.2±0.6	1.0±0.4	0.9±0.4	0.9±0.6	-0.18±0.7	0.81

Note: Values are Means+/-Standard deviation in millimoles per litre of blood

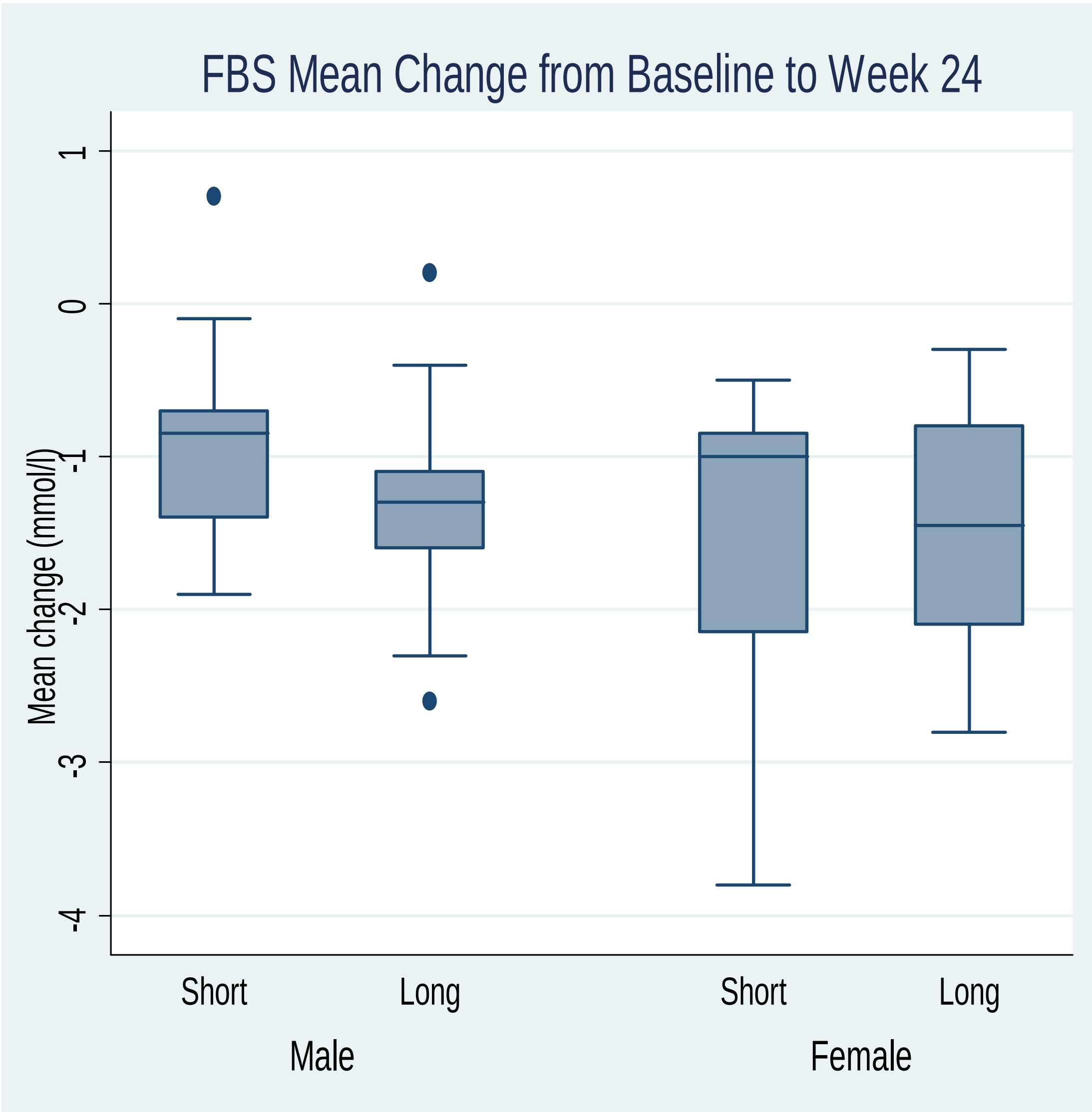

Figure 4: Mean change in fasting blood sugar between week 0 and week 24.

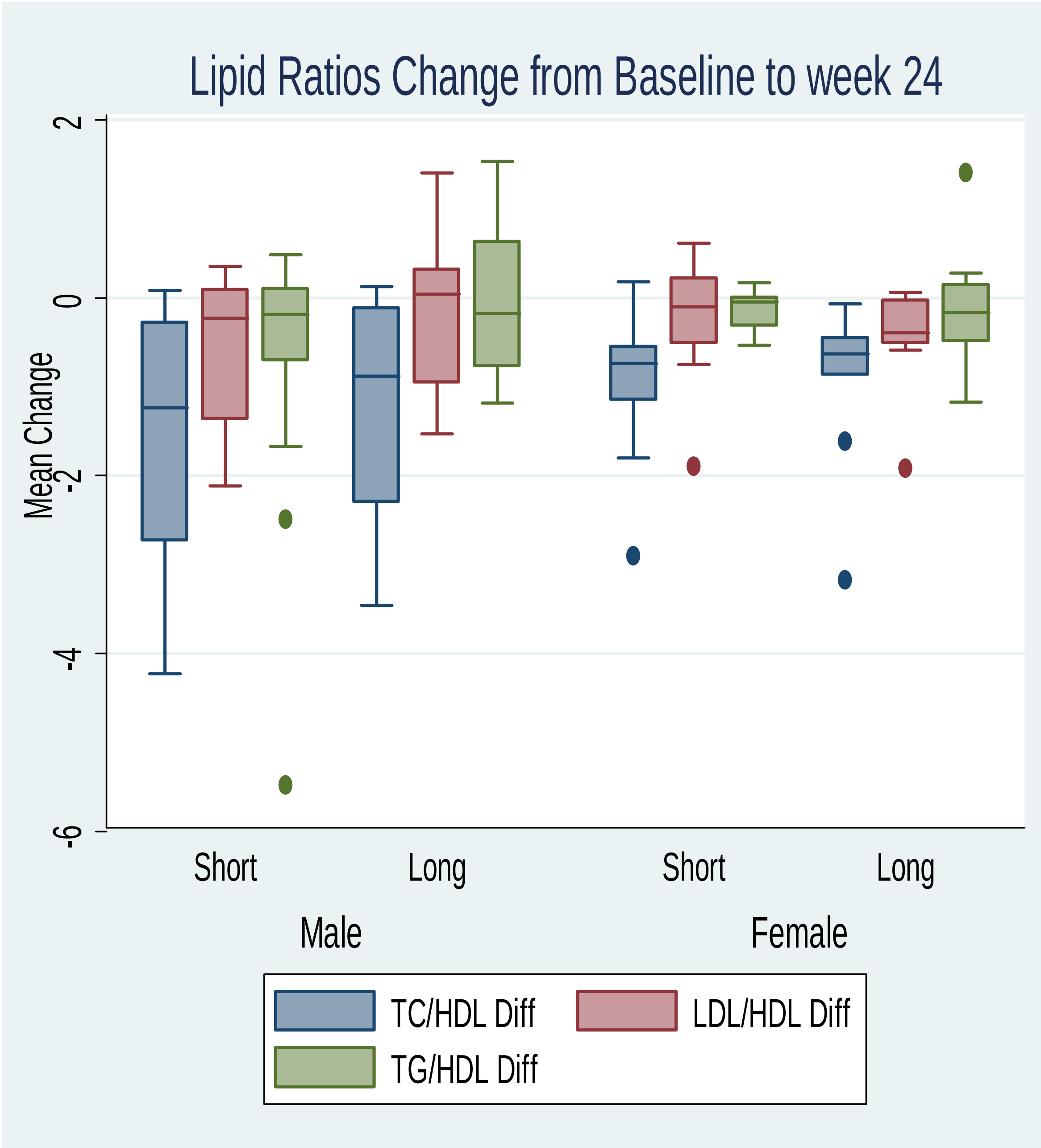

Figure 5: Mean change in lipid ratios between week 0 and week 24.

Table 9: Linear regressions (controlling for sex)

Mean change, Long	Coefficient	Standard Error	P>|t|	[95% Conf. Interval]	
FBS	-0.36	0.25	0.15	-0.87	0.14
TC	0.75	0.36	0.05	0.15	1.48
HDL	0.11	0.11	0.33	-0.11	0.33
LDL	0.29	0.23	0.20	-0.17	0.75
TG	0.30	0.24	0.22	-0.18	0.78
TC/HDL	0.13	0.34	0.70	-0.56	0.82
LDL/HDL	0.10	0.24	0.68	-0.38	0.58
TG/HDL	0.31	0.32	0.33	-0.33	0.95

Controlling for sex meant that analysis considered effect of the two regimes with sex taking a fixed value (i.e. data was pooled)

CHAPTER FIVE

Discussions:

5.1 Demographic, Body Composition and Cardio-metabolic Characteristics of Participants at the Baseline: What do they mean?

Baseline measurements from this study found that at the recruitment point, males were overweight while females were in the obese class I category. This has been associated with unfavorable health outcomes [110-112]. The high BMI of the participants in the study suggests that they were at an increased risk for cardiovascular disease and the associated metabolic syndrome. A few meta-analyses and cohort studies, however, propose that values within the 23-33kg/m^2 range have lower mortality risks among the elderly [113-116]. Thus, the higher BMI values as observed in the current study may actually be associated with better cardiovascular disease epidemiology in this cohort. Based on this, males in the current study were especially safer.

Recent studies now propose that WHtR is superior to traditional anthropometric measures for health such as BMI in assessing cardiovascular and metabolic risk among different races and ages [117-122]. Using the proposed WHtR cut-off of 0.5 above which cardiovascular health risk rises [119-121, 123], participants in the current study were at cardiovascular disease risk at recruitment. In fact, considering that this ratio is superior to BMI in assessing health risks and outcomes amongst apparently healthy populations as it particularly considers fat distribution [117, 118, 124], they had a considerably high risk for the metabolic syndrome.

A comparison of the baseline WHR against WHO cut-off guidelines of Ó0.90 (male) and Ó0.85 (female), associated with substantially increased metabolic complications [125], showed that around 4 in every 5 males had central/abdominal obesity with mean value above the WHO cut-off, as compared to 2 of every 5 females. This indicates that at the start point, males in this study had a relatively higher risk for metabolic syndrome and other health problems, and higher mortality risk associated with upper values of this measurement [112]. Males had twice the risk portrayed by their female counterparts based on WHR alone.

Determination of the basic lipid profiles is one approach to assess CRF amongst apparently healthy individuals and those with metabolic syndrome diagnoses. However, the use of the different lipid ratios is now more common. These ratios are now recognized to be independently associated with cardiovascular disease risks [126, 127]. When published cut-offs for unfavorable risk categories associated with poor cardiorespiratory fitness and cardiovascular disease were considered [126-128], nearly half of the males and females had baseline values above the cut-offs for TC/HDL ratios (above 5.0 for males and 4.5 for females). This suggests that these individuals were at substantial metabolic risks. Similarly, using the 3.5 (males) and 3.0 (females) proposed cut-offs for LDL/HDL, one third in both sexes in this study had higher values at the start of the study, and with the absolute means far above the cut-offs. While this alone also shows high health risks, combination of these two ratios above suggested enhanced metabolic syndrome risk for this elderly population at the point of first contact. Only a consideration of TG/HDL in exclusion from the other ratio-variables showed lower cardio-metabolic risks below 10% with respect to 3.5 (males) and 2.5 (females) cut-offs. The available TG/HDL cut-offs have only been proposed for European populations [128], however, and therefore, such an isolated finding does not conclude the population under study had minimal health risks based on this finding alone. There are no comparable studies for black populations to assess if racial differences might exist.

Assessment of the baseline basic lipid profiles showed that nearly half of the participants had TC levels above the reference cut-off for their respective sex, namely 5.2 (males) and 5.3 (females) mmol/l. Nearly half the participants were at a high risk of cardiovascular disease, since absolute TC level is independently associated with this disorder. For LDL values, close to one third of the participants had unfavorable values. A similar proportion had negative values for HDL levels, below the standard reference of <0.9mmol/l. Furthermore, with a large percentage of participants having high TG levels, all this points to a population with health risks at the point the follow-up protocol was started. In particular, using a combination of the various lipid profiles alone suggests that more than half of the sedentary-elderly Kenyan population from urban set-up is at risk, which is in agreement with a recent study from a Kenyan rural setting [129].

Currently, body composition reference data for the elderly African population is unavailable. While this is available elsewhere, it is based on non-African populations, and cause comparison difficulties where racial differences may be present. For instance, males and female in the current study had baseline percentage fat mass comparable with those from a study in an Indian population whose values were near similar percentages at 25 and 30, respectively, though it covered a wider age-range [130]. A 15-year bi-annual cross-sectional study to determine reference cut-offs for a US population found higher percentages for women, but the categorization was based on the various BMI subsets used for analysis, and therefore not entirely comparable with the baseline values of the current study [131]. The high baseline percentage body fat for the female in the current study, making well over one third of their body mass, and with a concurrent lower BD, is consistent with the baseline blood chemistry findings where the females had higher TC values. Based on Jackson and Pollock equations [106-108], males in this study had average baseline body fat but their female counterparts were obese at the start point.

In the baseline values of this study, participants showed impaired fasting blood glucose levels. Both sexes had pre-diabetic mean glucose values, a finding which is consistent with studies that reported elevated fasting levels of plasma glucose with age in other African populations [132, 133]. However, in this study females had higher means than their age-matched males at the start. These baseline findings differ from studies on both urban Nigerians and rural Kenyans [129, 134] that suggested higher values for males. Our study however comprised relatively older participants, which may have affected the outcome and comparison.

At the start, the mean pre-exertion systolic and diastolic BPs were within the normal ranges, i.e., below 140 and 90 mmHg, respectively. Further, the SBP rise and DBP decay observed at exhaustion from the SRT, and the return to normal ranges within the following five minutes of rest was within published values [135]. The 5-minutes post SRT blood pressure was similar to the pressure before the run test portraying good normalization. However, as nearly a quarter of the participants had pre-exertion BP above 140/90, this indicates that a significant proportion of the participants had hypertensive tendency at the point of recruitment into the study.

Based on reference $\dot{V}O_{2max}$ values provided by the American College of Sports Medicine [136], the mean values for the males and females at the baseline in this study were below values expected for their ages. Both males and female spent much less time in the SRT than expected for their age, which translated to lower $\dot{V}O_{2max}$. These showed reduced cardiorespiratory health consistent with their sedentary life style, the criterion used for inclusion.

Using the WHO and Alberti et al (2009) criterion for metabolic syndrome diagnosis, where at least three of the following criterion have to be present: waist circumference above 102 and 88 cm for males and females, respectively, HDL<1.0 mmol/l and <1.3 mmol/l in males and females, respectively, TG Ó1.7 mmol/l, SBP Ó130 mmHg or DBP Ó85 mmHg, and fasting blood glucose >5.6mmol/l [125, 137]), a high percentage of participants in this study showed unfavorable health characteristics at the point of recruitment. Well above half the males and females showed at least three features of the criteria for a positive metabolic syndrome diagnosis and appeared to have some form or grade of this syndrome. These baseline findings indicated a potentially poor future health outcome for this cohort as such clinical features have been shown to get worse with advancing age and adoption of sedentary lifestyles [45, 62]. The findings are consistent with other studies done in Kenya and the larger the East African region, which showed increasing prevalence of risk factors for cardiovascular disease and metabolic syndrome [6, 7, 9, 138] amongst the population. This being a follow-up study with an intervention, however, aimed at improving these health parameters for the participants studied.

5.2 Attrition Rates for the Different Home-Based Exercise Regimens.

Regardless of the type of exercise regime in terms of intensity and length of bouts, low adherence rates have been observed when drop-out rates are considered among elderly put on home-based exercise programs [139]. Higher adherence rates are associated with center-based supervised regimes where individuals meet to exercise together as opposed to each doing it alone at home, with completion rates ranging from 65-86% from a systematic review of prospective studies [139].

Information of drop-out rates amongst adults based on comparison between intermittent short-bouts and the traditional-longer bouts is minimal. Where studies have been done, the outcomes are either inconsistent or with mixed outcomes [23]. While some suggest minimal difference in exercise adherence between the short and the longer bouts [40], others, comparing the same in individuals with a specific health problem and drawn from the same sex suggest that intermittent as opposed to the continuous-longer bouts have better adherence outcomes [90]. Similar comparisons for sedentary elderly individuals is rare, and available studies though indicating potential benefits show higher attritions amongst those participating in the shorter bouts regime [24].

With such a disaggregation on bout-type amongst previously sedentary individuals, the current study shows that the elderly are more likely to adhere to exercise performed in short bout. The observed higher completion rate in both male and female participants on a shorter but more frequent exercise regime suggests this to be valid for both sexes. This observation of improved adherence has been shown in previous studies on obese and overweight females [105, 140] and agrees with recent data that intermittent short bouts have better adherence, at least amongst females [90]. A point of difference with Alizadeh et al (2013) who document enhanced adherence in obese and overweight women on short-boutsô prescriptions, our study showed reduced adherence when women had obesity compared to those with lower weights. The current study, however, considers all weight categories as opposed to only overweight and obese individuals. These findings, at least from our perspective, directly address the need to further examine adherence to different exercise programs [23] in a more definitive manner.

In this study, it appears logical to argue that when elderly individuals are put on the traditional bouts of moderate exercise, the first few weeks are the most critical when there is likely to be higher attrition. This is in contrast to documented findings of higher adherence in the initial follow-up period in technology-based exercise programs [141], probably because use of technology to encourage individuals may improve outcomes. Although the impact of the constant phone-based reminders in our studies had no comparative group, it is safe to assume that it probably enhanced adherence so that attrition rates were lower than would have been the case had this been left-out in the protocol. The drop-out rates observed were similar for both males and female after the first 8 weeks, and then stable afterwards for females but with males continuing to drop out, albeit at lower rates. This is a sharp contrast to previous data showing males having better adherence than women, although these were either older age groups (>70 years), involved supervisory follow-up, were from western economies, involved individuals with a prior health scare and, further, assessed a totally different exercise intervention (walking and training for balance and strength) [17, 139]. This adds value to recommendations for more in-depth experimental works on attrition to enable more consistent conclusions on which exercise regimes have higher adherence [23], and, further, suggests that males in our set-up are more likely than their female counterparts to drop out if on traditional-longer bouts of moderate intensity exercise.

From the current study, it seems plausible to suggest that if elderly-sedentary individuals are put on traditional exercise prescriptions, then they must be closely followed up and encouraged for the first few weeks as their bodies adjust. Males on long-bouts prescription need much closer attention not only in the critical first few weeks but well into the longer run. The fact that the proportion of males on longer sessions who completed their prescription was significantly lower than that for females further strengthens the need for alternative exercise regimes for male participants unless they are followed closely for adherence if on long-bout regimes. Our findings suggest that this could be addressed for both sexes by having all elderly individuals who have largely led sedentary lifestyles put on shorter bouts which appear more appealing given their higher adherence rates in this study.

Individuals with higher education are likely to have better adherence in longer bouts compared to their counterparts on the same prescription but with lower education attainment. The effect of higher education level on enhancing adherence has previously been proposed [139]. Thus, it seems plausible to suggest that because individuals on shorter exercise bouts have much lower attrition compared to the longer bouts, elderly subjects with lower education and, relatedly, probably lower understanding of the benefits of exercise participation on cardiorespiratory health, should especially be put on short-boutsô prescriptions as opposed to the long bouts.

Obesity was found to be present in three out of four individuals who dropped out during this study. This was especially so in males. A similar trend of lower adherence to exercise and physical activity has been observed in obese and overweight individuals [17]. Thus, obese individuals or those whose BMI is higher than the WHO categorization for normal range should be put on short-bouts exercise regimes when on exercise prescription, to enhance their adherence. This, together with the observation above that males had higher attrition from the longer-bout regimes when compared to the female suggests that males, especially obese males, should have short-bouts prescription if a choice has to be made between males and the females.

Thus, attrition rates are lower for elderly individuals on short bouts as the prescribed form of their home-based exercise regimes when compared to the traditional longer bouts, and it is feasible therefore to suggest that exercise adherence amongst the elderly sedentary individuals could be enhanced by advocacy of shorter-intermittent bouts.

5.3 The Maximal Oxygen Consumption Changes Produced by the Different Home-Based Exercise Regimen.

In line with the documented effect of moderate intensity exercise on $\dot{V}O_{2max}$ [142-144], values for males and female in the current study rose from the baseline to the study end-point. Of interest, however, is that there was a difference in the manner of this change for males but not the females when compared within sex group based on bout-type. Males in the accumulated shorter bouts spent longer on the SRT and subsequently exhibited higher $\dot{V}O_{2max}$ returns compared to their counterparts on long bouts. For the female, the time spent on SRT and $\dot{V}O_{2max}$ gains were similar for the two bouts. That short bouts may have higher yields in improving $\dot{V}O_{2max}$ has been demonstrated [40]. What is novel is that this higher improvement on both time taken on the SRT and also on $\dot{V}O_{2max}$ for participants on short bouts is exhibited in males but not in females. There are probable factors beyond the scope of this study that could contribute for this result.

Controlling for sex, regression for the difference in estimated $\dot{V}O_{2max}$ for the two exercise regimes showed that there was a positive, though weak, relationship between the short-boutsô exercise regimes and $\dot{V}O_{2max}$ improvement. That the rate of $\dot{V}O_{2max}$ change across the weeks showed either no difference whether participants were in the short or long boutsô group (for females) or that indeed the shorter bouts were better (for males) is suggestive that the effect of accumulated short-bouts exercise on $\dot{V}O_{2max}$ is at least similar to, if not better than the traditional bouts lasting more than 30 minutes as currently advocated.

A similar result has been reported in a study that used shorter experimental period. A four weeksô follow-up on individuals in intermittent short bouts compared to the traditionally longer bouts but both with cumulatively similar weekly exercise time showed no dissimilarities in $\dot{V}O_{2max}$ change [145]. Our findings add to the growing evidence that intermittent exercise programe performed such that the cumulative exercise time matches that of the traditional regime is at least as effective as the existing recommendation [12] in $\dot{V}O_{2max}$ improvement amongst the elderly. The current results further suggest that these benefits may actually be higher amongst the elderly males.

It is noteworthy, though, that neither of the exercise regimes helped participants achieve $\dot{V}O_{2max}$ levels advocated for their age after the follow-up period. While there was improvement for all groups, the attained $\dot{V}O_{2max}$ values remained below the proposed levels that correspond to better CRF outcomes. In fact, across all groups, the improvement was marginal, only rising from very poor and poor categories at the start point based on the Physical Fitness Certification Manual [136], to, at the most, fair. Probably longer follow-up periods would yield better improvements for this age bracket whose bodies may take longer to adjust and who have higher loss in aerobic power [146] compared to the younger populations.

5.4 The Effect of the Different Exercise Regimes on Cardiovascular Function.

There was a general decrease in BP and HR at various points of measurement during the protocol for all participants regardless of their exercise regime, over the 24 weeks. Values at rest (before the SRT), at exhaustion (from the SRT) and after 5 minutes of abscissa (rest from the SRT) all declined during the follow-up period. No demonstrable differences were found on this decline based on the exercise regime of the participants within any specific sex group. While exercise has been shown to improve various cardiovascular measurements thus reducing cardiovascular mortality and morbidity amongst the elderly in different ways [55, 147-150], what our study adds is that the short bouts lower BP and HR in a similar way as done by long bouts [12].

Until recently when Landram et al (2006) demonstrated that intermittent exercise bouts lasting 10 minutes each had comparable BP outcomes to the traditional longer bouts [145], few had ventured on sub-30 minutes per bout studies. More comparable studies have used bouts almost twice as long (15 minutes) as our experimental group, but with similar results [40]. In Landram et al (2006) however, a wider age range was used and the interval breaks between the short-bouts were set at 10 minutes. From our findings, we similarly argue that both in the elderly males and females, a prescription of shorter exercise bouts has at least as good an effect in improvement of BP and HR as does the traditional long bouts lasting at least 30 minutes per session.

For the two exercise regimes, no difference was observed in HR recovery after SRT throughout the experiment in both males and females. Further, in both exercise groups for males and females, the HR before (at rest) and immediately following the 5-minutes post SRT was lower at the end of the 24th week compared to the baseline. That no demonstrable difference was observed in the rate of HR recovery following the SRT at the end of the protocol underscores the similar importance of the short-bouts exercise regime in this study when compared to the traditionally prescribed protocol advocating longer bouts. Considering the current findings, our proposed short exercise bouts are as effective in near complete HR recovery associated with better cardiovascular health [151, 152] as are the traditional long-bouts as long as the exercise intensity is the same.

Studies have shown that PP modifies cardiovascular disease risk, establishing that it is an indicator for both cardiovascular mortality and morbidity, with lower values protective [153-155]. Our findings show that short bouts are as effective as the traditional long bouts in lowering PP, so that individuals who fail in their exercise recommendations as currently prescribed could benefit from performing shorter bouts. In our study, the resting, exhaustion and abscissa PP dropped over the 24-week period for both males and females in the two regimes. That no demonstrable difference was observed in PP reduction for both sexes in all the three PP categories (with the exception of exhaustion PP among males) shows that the drop effect for both exercise regimes was similar. For the males and using the exhaustion PP alone, our findings suggest that the short-bouts regimes could in fact be superior to the long-bouts regimes. Further work should however be undertaken to ascertain this given that our design favoured an equivalence as opposed to superiority comparison of two different means, and also based on fact there was no significant difference in this variable among the females drawn from the different regimes of exercise.

Recent works have equally shown that workouts lasting more than 45 minutes for a follow-up period of 8 weeks reduce PP [156]. Our study however, as far as we know, is the first to demonstrate that bouts lasting less than 10 minutes, performed more regularly, are equally as effective in this reduction of cardiovascular disease risk. This is especially so considering the few studies from the sub-Saharan Africa on exercise and CRF. It is noteworthy, though, that the participants in the current study had < 76 mmHg PP threshold suggested for better cardiovascular outcomes [154, 155]. Thus, based on resting and abscissa PP measured at various points and stages through the study, our participants had minimal cardiovascular disease risk.

The net effect of a similar general drop in SBP, DBP and PP for both males and female on prescriptions of the two different exercise regimes shows that in this population, the short bouts are as effective as the long ones in regulating these parameters. Based on this result, and barring any contraindications, short bouts should be prescribed with similar benefit for sedentary individuals of ages above 50 years.

5.5 Change in Body Composition.

Over the 24 weeks follow-up for both males and females, all variables associated with body composition were found to decrease in a similar manner regardless of the participantsô regime of exercise. Although most of the variables did not have their values drop to the recommended levels, the drop was significant nevertheless, and there was no demonstrable difference in the magnitude of these changes based on exercise performed.

Given that BMI drop amongst the elderly to normal values as provided by the international WHO classification [110] is a huge challenge, the percentage drop for our participants with BMI > 24.9 $kg/m^2$was a significant achievement. Short bouts appeared to halve the percentage of obese males at the end of the follow-up protocol with the long-bouts regime dropping the obese number by one-third. The long bouts for the female had a marginally higher proportion of the drop for the obese when compared with the shorter bouts. The finding, however, is consistent with a recent results that shorter-frequent exercise bouts are efficient in weight management in obese and overweight women [90]. Effectively, the reduction in the BMI for both males and female in the short bouts was similar to that observed in their longer boutsô counterparts, with the comparison of the mean change for different regimes within each sex showing no significant difference over the 24 weeks.

Lower values of WHtR are indicative of lower metabolic syndrome and cardiovascular disease risk [119, 120]. In this study, there was a drop in the percentage of both males and females on short bouts whose WHtR remained above 0.5 cut-off at the end of the follow-up. Similarly, the mean values for those whose ratio remained above 0.5 dropped. Regardless of the exercise regime and whether or not participants attained a mean value below 0.5, however, all participants in the current study showed a drop in their WHtR. While this drop was significant from the baseline to the end of the 24-week follow-up, there was a similar trend of no demonstrable difference in the rate of the change based on the exercise regime. No previous work we are aware of has compared the effect of intermittent and traditional regimes to WHtR in such a follow-up as our current work. Our results show that the two exercise regimes have similar modification of central obesity and body composition at large given that no difference was noticed in WHtR for the two regimes upon controlling for sex.

A similar picture was observed for WHR. There was a more than half reduction in the percentage of both males and females whose WHR remained above the WHO cut-off of Ó 0.9 and Ó 0.85, respectively [125], in both the short and the long bouts. The difference between the two bout-types, however, lacked significance. For participants whose values remained above the WHO threshold, short bouts were found to still decrease the absolute values in a similar manner as those in long bouts. Thus, no difference was demonstrable in the manner the two exercise regimes affected WHR, so that the short bouts were as effective as the long bouts in reducing abdominal obesity and therefore in reducing the risk associated with high values [112]. Upon controlling for sex, no difference was found between the short and the long bouts in WHR, further showing similarity in outcome of the two regimes.

Participants in this study had a drop in the percentage body fat, regardless of the exercise regime adopted. However, only the males were able to have a drop to within their recommended body fat percentage based on the ideal body fat percentage with widest reference [106]. The females had a significant drop as well regardless of their regime of exercise, but could not attain their recommended ranges [108]. This could be explained by fact that at the baseline, the female had demonstrated a high percentage body fat so that although there was a drop, only a longer follow-up period would have helped them attain the recommended levels. By a direct comparison of the two exercise regimes, the shorter bouts had a slightly although statistically insignificant advantage by causing an absolute higher mean drop in the fat percentage, in both males and female. Recent works on this area have found bouts lasting less than 10 minutes to be equally effective in lowering body fat in males [157] and female [90] when cumulative intermittent bouts are considered. That our study found no difference between the two exercise regimes upon controlling for sex in this variable further shows that a short bouts regime of moderate intensity exercise is at least as good as the traditional longer bouts in the regulation of body fat across sexes.

5.6 Changes in Metabolic Markers.

Broadly, regardless of the exercise regime adopted for both males and female, there was an improvement in most of the metabolic profiles measured. Total cholesterol and the various lipid ratios dropped throughout the 24 weeks for both the short and the long bout-groups. For HDL, which actually rises with exercise [158, 159], participants in the current study had their values increased. The percentage of those whose values were below 0.9 mmol/l cut-off that had been drawn to the short bouts dropped from 18.5% and 7.7% for the males and the females respectively, to 0%. The males on longer bouts whose HDL remained low remained at 11.1% and the decrease in the females was from 15.4% to 3.8%. Considering these percentages, the short bouts appeared superior in HDL improvement. For the LDL and TG values, the change was marginal. Males and females on long bouts had a slight rise in both LDL and TG. The same measurements had minimal to slight improvement amongst the short bout individuals. A drop in the mean FBS also occurred. Deeper scrutiny of the individual variables and their changes showed a number of valuable outcomes, below.

Baseline basic lipid profiles had shown that nearly half of males and female were at risk for cardiovascular disease. They had TC levels above the reference cut-off for their sex.

Following completion of the study, nearly half of the males from the short bouts who had started with unfavourable TC attained recommended values compatible with good health outcomes. Additionally, there was a drop in the mean value of TC in those who failed to attain the recommended values, and whose number was now lower. This trend of lowered TC was observed in males from the long bouts, indicating that the two regimes were comparable. There was a reduction in the percentage that remained with values above the recommended cut-off. Further, the mean TC values decreased for not only the whole group but also in those failing to attain TC values below 5.2 mmol/l. When the mean change in TC was considered, comparing the baseline to the end-point values, the two regimes were similar in the magnitude of the change. Both had similar effect in the mean change, attaining significant differences between weeks 0 and 24.

Amongst the females, except for the mean change for TC that was significantly higher for short bouts, suggesting that it could be superior to the longer bouts, no difference could be shown in TC changes. This suggests similarity in the two regimes amongst the female as well. It is noteworthy that while about 2 in 3 females on short bouts had high TC at baseline their values dropped to within the recommended range, while none in the long bouts achieved this feat. The two regimes, however, had comparable significant in the overall mean of TC and their respective means for the participants unable to achieve the reference cut-off. When the values at the start point were compared with those at the end point, the mean change was similar for the two regimes. Thus, basing on TC alone, no demonstrable difference could be shown between the short bouts and the long bouts for both males and females in this study.

When lipid ratios were considered, given the fact they also independently relate with cardiovascular disease and metabolic syndrome risks [126-128], an even more elaborate effect of the exercise regimes was noticed. The males and females in the short bouts whose respective TC/HDL was lowered to below the 5.0 and 4.5 cut-off was approximately 2 in 3 of the baseline numbers. This drop was higher among males in the short bouts compared to long bout males whose TC/HDL drop was only found in 4 males. Previously, it has been suggested that intermittent exercise regimes may actually be superior in some attributes of health improvement when compared to the traditional regimes [40]. For the females, long bouts had a marginally better effect on this ratio, with 4 in 5 females from this regime attaining the recommended range of TC/HDL. This current finding among the female contrasts that proposed by Quinn et al (2006), but our experiment, however, was twice longer, and our short bout length was shorter than that that in their study. Given that the long bouts have already been shown in our study to lower TC in a lesser manner compared to the short bouts, this seemingly contradictory finding would be best explained from the perspective of the longer bout raising HDL marginally higher (although not statistically) than the short bouts in the female as our results show, so that the ratio, which factors HDL as the denominator, drops more. For both the males and the females in the two exercise regimes, however, the drop in the mean TC/HDL for participants who did not achieve the recommended levels was similar. Using this ratio, the effect of the two exercise regimes could not be differentiated, and the apparent dissimilarity in the effect amongst women was not supported by controlling for sex, and, further, by fact that the mean changes for participants in the two regimes were alike. Thus, the two regimes have similar effects on TC/HDL in both males and females.

The LDL/HDL showed a slightly lower change rate though the overall trend was similar when compared between the two regimes for both male and female. In the males performing short bouts, 1 in 2 whose baseline values were above the 3.5 cut-off attained favourable values by the end of the follow-up. This compared to just under 1 in 2 for the males in the long bouts, and with no significant difference in the overall mean change of LDL/HDL in the entire period. The two regimes were further comparable when considering the mean LDL/HDL drop in those who failed to attain their recommended values. For the females, those in the short bouts had just under 1 in 2 that started with high values attaining the required threshold and for their long bouts counterparts, about 2 in 3 attained the same feat. As found in the TC/HDL, the shorter bouts here too appeared more favourable for the males although they still attained good results for the females given that the marginally higher drop in LDL/HDL for those in the long bouts over the short bouts had no statistical significance.

Based on the ratios of TC/HDL and LDL/HDL, it is apparent that the two exercise regimes had a similar manner of the reduction of their reduction and therefore also reducing cardiovascular disease risk. That short bouts have comparable benefits to long bouts in lowering TC/HDL and LDL/HDL could thus address the baseline finding that showed these ratios high in our participants, as has also been shown in other local studies [129]. Males and females would thus have the similar benefit of TC/HDL and LDL/HDL reduction whether put on short or long bouts of exercise.

Overall, using the various lipid profiles and their related ratios, resultant effect of short bout exercise regime in these participants suggest that no difference exists when they are compared to the longer bouts - they show similar reduction in metabolic risk in previously sedentary elderly adults.

For the FBS, there also was noted an improvement from the high levels at baseline for all groups. For the males, the pre-diabetic and diabetic numbers observed before the start of the protocol were reduced by a factor of 4 for those in the short bouts regime compared to a factor of 9 for the long bouts. However, looking at the mean values, the mean change for those in the shorter bouts and those in the longer bouts was statistically similar. In fact, the mean values for those who remained in the pre-diabetic to diabetic values was lower for the males on the shorter bouts compared to the longer bouts, so that not much difference could be identified between the two regimes amongst the males after the 24 weeks of follow-up. The picture for the females was such that all female whose baseline FBS were in the pre-diabetic to diabetic levels and ended in the short sessions (46.2% of all female) were able to attain normal FBS levels after the 24 weeks of intermittent moderate exercise. Those in the longer sessions only managed a 4 factor drop from a baseline percentage of 42.3 to 11.5. The mean change in the absolute FBS values between the baseline and the end-point were similar for the females drawn from the two regimes. When linear regressions were done controlling for sex, there was no significant difference between the two regimes in the rate of mean change in FBS. The already described apparent advantage long bouts have over the short amongst the males and that short bouts have over the long bouts amongst the female based on percentage drop of individuals with high FBS therefore does not suffice. This, coupled with the fact that there was no difference in the mean change for the variable in both males and female performing the different sessions over 24 weeks further support the hypothesis there is no difference in the effect of the two. Thus, elevated FBS would be adequately regulated not only by utilizing the already established traditional exercise regimes but also, for those who opt to, by adopting the shorter/intermittent regimes.

Limitations.

The criteria for spousal inclusion may have affected adherence. Spousal backing has been documented to help reduce attrition rates from prescribed exercise interventions [160]. The print advertisement of the study favoured self-selection of those able to read, compromising inference to the general population. Further, non-blinding and failing to consider lifestyle behaviours such as smoking history and diet could have confounded our study. Body composition measurements such as the 3-point skin fold measuresô method is subjective by being dependent on the observer, although this was overcome by having the same researcher conduct measurements in all participants throughout the protocol. The protocol also did not cater for non-exercise activity thermogenesis and this may have affected the results nor perform quality control measures associated with verification that activity monitors were actually used by study participants and not exchanged at home. Additionally, investigators used indirect methods for $\dot{V}O_{2max}$ estimation, where expired gases were not measured, considered fasting glucose levels and not HBA_{1c}, and did not ask the HIV status of participants or whether female participants were post-menopausal or not. These limitations may have affected the values we report.

Conclusions.

In this study we fail to reject the null hypothesis that for elderly adults in Kenya, exercise performed in accumulated shorter bouts of < 10 minutes achieves the same level of improved CRF, and, have the same adherence rates, as the longer bouts in their currently prescribed form of 30-60 minutesôbouts. Shorter bouts have higher adherence, and, further, they yield similar CRF benefits as the traditional-longer regimes. Thus, our results show that accumulated short bouts of moderate intensity exercise are at least as good in improvement of CRF as the longer bouts in elderly adults, and have lower attrition rates.

Recommendations.

We recommend that short-intermittent bouts of moderate intensity exercise can be adopted for benefit of sedentary older adults at the same level, if not higher, than the currently existing prescription of long bouts that last at least half an hour per session. There is evidence that the CRF outcome would improve, and, there would be higher adherence rate.

We further recommend that a superiority study be undertaken that would put into perspective which of the two studied regimes is actually better, as the current study in design was only meant to test for equivalence.

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Appendix 1: Informed Consent Form

Study Title: Cardiorespiratory effects of frequent short-sporadic moderate intensity exercise bouts in relation to the traditional continuous bouts amongst previously sedentary adults aged ≥50 years in Kenya.

Investigator: Karani Magutah (PhD Student) - Box 4606 (30100), Eldoret.

Purpose and background:

The study is primarily aimed at assessing the cardio-respiratory fitness patterns amongst Kenyans aged above 50 years.

Procedure:

If you consent to, you will be interviewed, your basic respiratory and cardiovascular function tested following which your endurance will be assessed by use of a 20M shuttle run test.

Benefits:

No direct benefit from participating in this study is envisaged. However, participants will be informed of their CRF values if they need to know. Further findings will be published as a first in understanding CRF issues among the elderly in Kenya, and providing an additional reference in the control of non-communicable diseases in the country.

Risk:

There is no known /anticipated direct risk to the participants in the study. However, maximal exertion may cause syncope or other forms of discomfort but a qualified first aider will be available during your test.

Confidentiality:

All information and measurements will be considered confidential, and consent forms used locked to prevent loss of confidentiality to participants.

Right to refuse or withdraw:

Your participation in the study is entirely voluntary and you are free to refuse to take part or withdraw at any time.

If you consent, please indicate so by signing (or allowing a thumb print) this form:

I agree to participate in this study: é é é é é é é é DATE:é é é é é é é é é é ..

Appendix 2: Study Participants Advertisement

(Approval Number 0001242).

We, Karani Magutah of Moi University School of Medicine team, seek to recruit healthy volunteers to a follow-up study on Cardiorespiratory Fitness for individuals aged Ó50 years, from either sex.

The study will be conducted within the MTRH area.

Participants will be randomized into either of two groups to receive different exercise prescriptions.

This study is expected to last 6 months and will entail close follow-up in participation of the prescribed exercise protocols, with outcome measures at 8 weeksô intervals.

This may be intensive.

The study, however, has benefits, apart from advancing knowledge, on the exact effect of different exercise prescriptions for individuals at risk of chronic-lifestyle diseases. You will know your lipid profiles, your cardio-respiratory fitness levels, and other crucial biomarkers of health and fitness as they change with the prescription every 8 weeks for the six months.

Volunteers are requested to get in touch @ 0721 545 063.

Thank you

Appendix 3: Participants Record Form/Questionnaire

Study Number:

Sex ....

Date of Birth é é é é é

Residence é é é é é é .

Number of years lived here é é é é é é .

Level of education é é é é é é é é é ..

Occupation ....

Last known date (year) of planned/programmed exercise é é é é é

Last known date (year) of hard physical labour/activities .é é é é é

Baseline Height: é é é é é é cm Weight: é é é .. kg BMI: é é é é .. kg/m^2

After 8 weeks Weighté é é é .Kg BMI:é é é é é kg/m^2

After 16 weeks Weighté é é é .Kg BMI:é é é é é kg/m^2

After 24 weeks Weighté é é é .Kg BMI:é é é é é kg/m^2

Blood Pressure (Note: All measures conducted after five minutes of continued rest ï sitting)

Week 0 (Baseline)

(1st é é é ..over é é é é ..mmHg; 2nd é é é é .overé é é .é .mmHg)

After 8 wks (baseline i.e before test)

(1st é é é ..over é é é é ..mmHg; 2nd é é é é .overé é é .é .mmHg)

After 16 weeks (before test)

(1st é é é ..over é é é é ..mmHg; 2nd é é é é .overé é é .é .mmHg)

After 24 weeks (before test)

(1st é é é ..over é é é é ..mmHg; 2nd é é é é .overé é é .é .mmHg)

Estimated Maximal Heart Rate (MHR) 220-Age = é é é é é é é ..

Heart rate: (Note: All measures conducted after five minutes of continued rest ï sitting)

Week 0 (Baseline) (before test) é é é é .B/M

After 8 weeks (before test) é é é é .B/M

After 16 weeks (before test) é é é é .B/M

After 24 weeks (before test) é é é é .B/M

Waist-hip-ratio

Baseline week 0 é é é é é é .. [Waisté é é é é ..cm; Hipé é é é é ..cm]

Week 8 é é é é é é é [Waisté é é é é ..cm; Hipé é é é é ..cm]

Week 16 é é é é é é é [Waisté é é é é ..cm; Hipé é é é é ..cm]

Week 24 é é é é é é é [Waisté é é é é ..cm; Hipé é é é é ..cm]

Waist-Height-ratio

Baseline week 0 é é é é é é .. [Waisté é é é é ..cm; Hté é é é é ..cm]

Week 8 é é é é é é é [Waisté é é é é ..cm;

Week 16 é é é é é é é [Waisté é é é é ..cm;

Week 24 é é é é é é é [Waisté é é é é ..cm;

Skin fold (Triceps (Chest for males), Iliac Crest (Abdominal for males) and Thigh in that order)

Baseline week 0 é é é ., é é é .é and é é .. é mm

Week 8 é é é ., é é é .é and é é .. é mm

Week 16 é é é ., é é é .é and é é .. é mm

Week 24 é é é ., é é é .é and é é .. é mm

Time spent on (*SRT)/ level reached

Baseline week 0 é é é é é é ..

Week 8 é é é é é é é

Week 16 é é é é é é é

Week 24 é é é é é é é

HR at exhaustion/discontinuation from test

week0é é é é . week8é é é é week16 é é é é . Week24é é é é ..B/M

Estimated $\dot{V}O_{2max}$(Relative)

Week 0 test é é é é é é ..mm/kg/min

Week 8 test é é é é é é ..mm/kg/min

Week 16 test ...é é é é ...é mm/kg/min

Week 24 test é é é é é é ...mm/kg/min

Recordings during the Abscissa (Rest Period)

Week 0

Note: BP to be measured only at exhaustion and after 5 minutes of rest, PR every minute.

Time (mins after discontinuation from protocol)	BP	PR
At exhaustion		
60 s		
120 s		
180 s		
240 s		
300 s		

Fasting Blood glucose (morning) before exercise testé é é é ..é é é .

Week 8

Note: BP to be measured only at exhaustion and after 5 minutes of rest, PR every minute.

Time (mins after discontinuation from protocol)	BP	PR
At exhaustion		
60 s		
120 s		
180 s		
240 s		
300 s		

Fasting Blood glucose (morning) before exercise testé é é é ..é é é .

Week 16

Note: BP to be measured only at exhaustion and after 5 minutes of rest, PR every minute.

Time (mins after discontinuation from protocol)	BP	PR
At exhaustion		
60 s		
120 s		
180 s		
240 s		
300 s		

Fasting Blood glucose (morning) before exercise testé é é é ..é é é .

Week 24

Note: BP to be measured only at exhaustion and after 5 minutes of rest, PR every minute.

Time (mins after discontinuation from protocol)	BP	PR
At exhaustion		
60 s		
120 s		
180 s		
240 s		
300 s		

Fasting Blood glucose (morning) before exercise testé é é é ..é é é .

Baseline (week 0) Lipid profile

Total cholesterol	Triglycerides	LDL	HDL

8th week Lipids profile

Total cholesterol	Triglycerides	LDL	HDL

16th week Lipids profile

Total cholesterol	Triglycerides	LDL	HDL

24th week Lipids profile

Total cholesterol	Triglycerides	LDL	HDL

Appendix 4a: Home-Exercise Checklist - Short bouts

Typical Weekly Workouts Completed (Adapted from WHO GPAQ questionnaire and showcard):

Jogged (the mandatory prescription for all) or participated in any other activities under Moderate Physical Activity or exercise as per attached GPAQ generic showcard:

for between 5-10 minutes 3 times on Monday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Tuesday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Wednesday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Thursday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Friday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Saturday	Yes	NO	Others (Specify)
for between 5-10 minutes 3 times on Sunday	Yes	NO	Others (Specify)

The same protocol shall be maintained for each of the 8 weekly phases

**At the end of each 8 weeks, repeat 20 m SRT (as at the baseline) will be done, with the various related cardiovascular measures (methods) before, during at after the protocol (recovery period) also determined.

Appendix 4b: Home-Exercise Checklist – Traditional bouts.

Typical Weekly Workouts Completed (Adapted from WHO GPAQ questionnaire and showcard):

Jogged (the mandatory prescription for all) or participated in any other activities under Moderate Physical Activity or exercise as per attached GPAQ generic showcard:

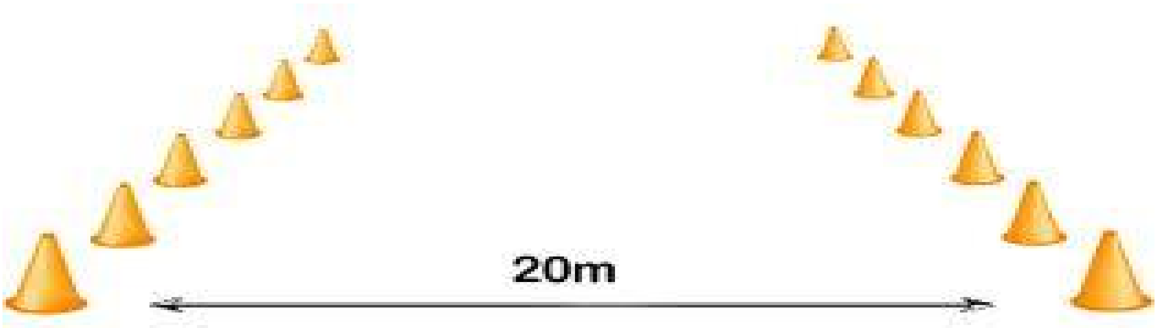
Note: This need only be done for 30-60 minutes three to five (3-5) times in a week

for between 30-60 minutes on Monday	Yes	NO	Others (Specify)
for between 30-60 minutes on Tuesday	Yes	NO	Others (Specify)
for between 30-60 minutes on Wednesday	Yes	NO	Others (Specify)
for between 30-60 minutes on Thursday	Yes	NO	Others (Specify)
for between 30-60 minutes on Friday	Yes	NO	Others (Specify)
for between 30-60 minutes on Saturday	Yes	NO	Others (Specify)
for between 30-60 minutes on Sunday	Yes	NO	Others (Specify)

The same protocol shall be maintained for each of the 8 weekly phases

**At the end of each 8 weeks, repeat 20 m SRT (as at the baseline) will be done, with the various related cardiovascular measures (methods) before, during at after the protocol (recovery period) also determined.

Appendix 5: The SRT and the Beep Test Recording Sheet



Shuttle run test arrangement (cones)

Date: _______________ Time: ____________ Weather Conditions:

Level 1	1 2 3 4 5 6 7
Level 2	1 2 3 4 5 6 7 8
Level 3	1 2 3 4 5 6 7 8
Level 4	1 2 3 4 5 6 7 8 9
Level 5	1 2 3 4 5 6 7 8 9
Level 6	1 2 3 4 5 6 7 8 9 10
Level 7	1 2 3 4 5 6 7 8 9 10
Level 8	1 2 3 4 5 6 7 8 9 10 11
Level 9	1 2 3 4 5 6 7 8 9 10 11
Level 10	1 2 3 4 5 6 7 8 9 10 11
Level 11	1 2 3 4 5 6 7 8 9 10 11 12
Level 12	1 2 3 4 5 6 7 8 9 10 11 12
Level 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Level 14	1 2 3 4 5 6 7 8 9 10 11 12 13
Level 15	1 2 3 4 5 6 7 8 9 10 11 12 13
Level 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14
Level 17	1 2 3 4 5 6 7 8 9 10 11 12 13 14
Level 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Level 19	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Level 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Level 21	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

* circle the level reached for each participant, and write their name next to that line.

Appendix 6: Global Physical Activity Questionnaire (GPAQ) and Show Card.

GPAQ

Physical Activity			
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. *[Insert other examples if needed].* In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.			
Questions		**Response**	**Code**
Activity at work			
1	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like *[carrying or liftingheavy loads, digging or construction work*] for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 4*	P1

2	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days ȼƄĐ	P2
3	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes ȼƄϱ ƄĐ: ȼƄϱ ƄĐ hrs mins	P3 (a-b)
4	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads*] for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 7*	P4
5	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days ȼƄĐ	P5
6	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes ȼƄϱ ƄĐ: ȼƄϱ ƄĐ hrs mins	P6 (a-b)
Travel to and from places			

The next questions exclude the physical activities at work that you have already mentioned.

Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. [insert other examples if needed]

7	Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to P 10*	P7
8	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days ƈ Ƅ Đ	P8
9	How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes ƈ Ƅ ǫ Ƅ Đ: ƈ Ƅ ǫ Ƅ Đ hrs mins	P9 (a-b)
10	Do you do any vigorous-intensity sports, fitness or recreational (*leisure*) activities that cause large increases in breathing or heart rate like [*running or football,]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 13*	P10
11	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (*leisure*) activities?	Number of days ƈ Ƅ Đ	P11

12	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes ƈƀƺƀĐ: ƈƀƺƀĐ hrs mins	P12 (a-b)

13	Do you do any moderate-intensity sports, fitness or recreational *(leisure)* activities that causes a small increase in breathing or heart rate such as brisk walking, (*cycling, swimming, volleyball*)for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P16*	P13
14	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (*leisure*) activities?	Number of days ƈƀĐ	P14
15	How much time do you spend doing moderate-intensity sports, fitness or recreational (*leisure*) activities on a typical day?	Hours : minutes ƈƀƺƀĐ: ƈƀƺƀĐ hrs mins	P15 (a-b)
	Sedentary behavior		

The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but do not include time spent sleeping.

[INSERT EXAMPLES] (USE SHOWCARD)

16	How much time do you usually spend sitting or reclining on a typical day?	ƈ ƅ ǫ ƅ Đ: ƈ ƅ ǫ ƅ Đ Hours : minutes hrs min s	P16 (a-b)

WHO GPAQ Generic Show Cards

Vigorous Physical Activity at Work

Examples for vigorous activities at WORK	**VIGOROUS Intensity Activities** Make you breathe much harder than normal • Include Forestry (cutting, chopping, carrying wood), Sawing hardwood, Ploughing, Cutting crops (sugar cane), Gardening (digging), Grinding (with pestle), Labouring (shovelling sand), Loading furniture (stoves, fridge), Instructing spinning (fitness), Instructing sports aerobics, Sorting postal parcels (fast pace), Cycle rickshaw driving

Moderate Physical Activity at Work

Examples for MODERATE activities at work

MODERATE Intensity Activities

Make you breathe somewhat harder than normal

Include Cleaning (vacuuming, mopping, polishing, scrubbing, sweeping, ironing), Washing (beating and brushing carpets, wringing clothes (by hand), Gardening, Milking cows (by hand), Planting and harvesting crops, Digging dry soil (with spade), Weaving , Woodwork (chiselling, sawing softwood), Mixing cement (with shovel), Labouring (pushing loaded wheelbarrow, operating jackhammer), Walking with load on head, Drawing water, Tending animals



Vigorous Physical Activity during Leisure Time

Examples for VIGOROUS activities during LEISURE TIME	**VIGOROUS Intensity Activities** Make you breathe much harder than normal • Include: Soccer, Rugby, Tennis, High-impact aerobics , Aqua aerobics, Dancing, fast swimming



MODERATE Intensity Activities

Make you breathe <u>somewhat</u> harder than normal




Other examples

- Cycling, Jogging , Dancing , Horse-riding , Yoga, Pilates, Low-impact aerobics
- Cricket

Appendix 7: Normative Values for VO2max

Female (values in ml/kg/min)

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0 - 30.9	31.0 - 34.9	35.0 - 38.9	39.0 - 41.9	>41.9
20-29	<23.6	23.6 - 28.9	29.0 - 32.9	33.0 - 36.9	37.0 - 41.0	>41.0
30-39	<22.8	22.8 - 26.9	27.0 - 31.4	31.5 - 35.6	35.7 - 40.0	>40.0
40-49	<21.0	21.0 - 24.4	24.5 - 28.9	29.0 - 32.8	32.9 - 36.9	>36.9
50-59	<20.2	20.2 - 22.7	22.8 - 26.9	27.0 - 31.4	31.5 - 35.7	>35.7
60+	<17.5	17.5 - 20.1	20.2 - 24.4	24.5 - 30.2	30.3 - 31.4	>31.4

Male (values in ml/kg/min)

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0 - 38.3	38.4 - 45.1	45.2 - 50.9	51.0 - 55.9	>55.9
20-29	<33.0	33.0 - 36.4	36.5 - 42.4	42.5 - 46.4	46.5 - 52.4	>52.4
30-39	<31.5	31.5 - 35.4	35.5 - 40.9	41.0 - 44.9	45.0 - 49.4	>49.4
40-49	<30.2	30.2 - 33.5	33.6 - 38.9	39.0 - 43.7	43.8 - 48.0	>48.0
50-59	<26.1	26.1 - 30.9	31.0 - 35.7	35.8 - 40.9	41.0 - 45.3	>45.3
60+	<20.5	20.5 - 26.0	26.1 - 32.2	32.3 - 36.4	36.5 - 44.2	>44.2

Table Reference: The Physical Fitness Specialist Certification Manual, The Cooper Institute for Aerobics Research, Dallas TX, revised 1997 printed in Advance Fitness Assessment & Exercise Prescription, 3rd Edition, Vivian H. Heyward, 1998.p48.