Published in final edited form as:
Qual Life Res. 2008 April ; 17(3): 377–385. doi:10.1007/s11136-008-9319-4.

The effects of exercise training on quality of life in HAART-treated HIV-positive Rwandan subjects with body fat redistribution

Eugene Mutimura,
Faculty of Allied Health Sciences, Kigali Health Institute, P. O. Box 3286, Kigali, Rwanda, eumuran@yahoo.co.uk

Aimee Stewart,
School of Therapeutic Sciences, University of the Witwatersrand, Johannesburg, South Africa, aimee.stewart@wits.ac.za

Nigel J. Crowther,
Department of Chemical Pathology, National Health Laboratory Service, University of the Witwatersrand, Johannesburg, South Africa, nigel.crowther@nhls.ac.za

Kevin E. Yarasheski, and
Division of Endocrinology, Metabolism & Lipid Research, Department of Internal Medicine, Washington University School of Medicine, St. Louis, MO, USA, key@im.wustl.edu

W. Todd Cade
Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO, USA, tcade@wustl.edu

Abstract

Objective—Our objective was to examine the effects of exercise training (EXS) on quality of life (QoL) in highly active antiretroviral therapy (HAART)-treated HIV-positive (HIV+) subjects with body fat redistribution (BFR) in Rwanda.

Methods—The effects of a randomised controlled trial of EXS on QoL were measured using World Health Organisation Quality of Life (WHOQOL)-BREF in HIV+ subjects with BFR randomised to EXS (n = 50; BFR + EXS) or no exercise training (n = 50; BFR + noEXS).

Results—At 6 months, scores on the psychological [1.3 (0.3) vs. 0.5 (0.1); $P < 0.0001$], independence [0.6 (0.1) vs. 0.0 (0.0); $P < 0.0001$], social relationships [0.6 (0.2) vs. 0.0 (0.0); $P < 0.0001$] and HIV HAART-specific QoL domains [1.4 (0.2) vs. −0.1 (0.2); $P < 0.0001$] improved more in BFR + EXS than BFR + noEXS group, respectively. Self-esteem [1.3 (0.8) vs. 0.1 (0.6); $P < 0.001$], body image [1.5 (0.6) vs. 0.0 (0.5); $P < 0.001$] and emotional stress [1.6 (0.7) vs. 0.2 (0.5); $P < 0.001$] improved more in the BFR + EXS group than BFR + noEXS group, respectively. Psychological [1.5 (0.2) vs. 1.1 (0.3); $P < 0.0001$], social relationship [0.8 (0.2) vs. 0.4 (0.2); $P < 0.0001$], and HIV HAART-specific well-being [1.8 (0.2) vs. 1.0 (0.0); $P < 0.0001$] improved more in BFR + EXS female than male subjects.

Conclusions—Exercise training improved several components of QoL in HAART-treated HIV+ African subjects with BFR. Exercise training is an inexpensive and efficacious strategy for

Correspondence to: Eugene Mutimura.

improving QoL in HIV+ African subjects, which may improve HAART adherence and treatment initiatives in resource-limited areas of sub-Saharan Africa.

Keywords

Africa; HAART; Lipodystrophy; Rwanda

Introduction

The management of HIV infection with highly active antiretroviral therapy (HAART) has improved the survival rate of HIV-positive (HIV+) patients [1], although it is associated with anthropometric and metabolic abnormalities [2, 3]. In particular, body fat redistribution (BFR) may reveal a person's serostatus, resulting in stigmatisation and impaired psychosocial well-being [4]. Therefore, despite HAART-associated improvements in morbidity and mortality, BFR associated with HIV and HAART may result in diminished quality of life (QoL). As efforts to improve access to HIV treatment in resource-limited areas such as sub-Saharan Africa increase [5], strategies to manage the adverse effects of BFR on QoL become more crucial, as these management strategies may enhance treatment adherence [6]. Measures of QoL provide valuable information about patients' well being, psychological and social functioning, and the cost-effectiveness of intervention trials [7]. Therefore, there is a need to test and identify effective interventions that may alleviate the psychological and social consequences of HAART- and HIV-related BFR and enhance QoL of HIV+ patients receiving HAART.

The effects of BFR abnormalities on patients' QoL [8, 9], the aetiology and prevalence of BFR [2, 3, 10] and strategies to manage metabolic disorders associated with BFR [11 12] have all been previously studied. However, there remains a paucity of information on the effects of interventions such as exercise training (EXS) on QoL in HAART-treated HIV+ patients with BFR in sub-Saharan Africa where the prevalence of HIV is highest in the world and access to HIV treatment is improving. EXS has been reported to improve psychological well-being, physical functioning and promote independence in an HIV population [13, 14]. EXS has also been reported to alleviate negative psychological states and promote positive mood, vigour and well-being in both healthy individuals and other patient populations [15, 16]. We tested whether EXS improves domains of QoL in HAART-treated HIV+ patients with BFR and whether EXS can reduce self-perceived BFR. We therefore examined the effects of a 6-month randomised controlled trial of EXS on QoL in a Rwandan population of HAART-treated HIV+ subjects with BFR.

Methods

Subjects

Subjects were screened for eligibility from August 2005 to July 2006 at Centre Hospitalier Universitaire de Kigali Treatment and Research AIDS Centre and HIV/AIDS clinics in Kimironko, Kicukiro, Bilyogo-Nyiranuma, Kinyinya and Kacyiru in Rwanda. Eligible volunteers had documented histories of HIV infection, were 21–50 years old and had received World Health Organisation (WHO)-recommended HAART for ≥6 months. After obtaining permission from Research Ethics Committees in Rwanda and South Africa, written informed consent was obtained from eligible volunteers before participation. Subjects completed a published, validated, Objective Case Definition of Lipodystrophy questionnaire that utilised self-reporting to rate changes in body fat content [17, 18] of the face, the dorsocervical region, arms, breasts, abdomen, buttocks or legs. BFR changes must have occurred after initiation of HAART. Changes in fat content of these different regions were rated by the participants using a scoring system on a scale of 1–4. Thus, the severity of fat accumulation and/or lipoatrophy at each body site were rated by the participant as absent (score of 1), mild (noticeable on close inspection, score of 2), moderate (readily noticeable by patient or physician, score of 3) or severe (readily noticeable to a casual observer, score of 4). The scores for each body site were then combined to give a total BFR score. This same scoring system was also used by subjects to rate their overall change in body fat content from absent to severe. The scores for fat changes at each body site and the score for overall body fat change were confirmed by physical examination in which three clinicians working in the field of HIV/AIDS gave a consensus body-site and overall score to each patient. For the purposes of this study, HIV+ volunteers were enrolled if they had a moderate (score 3) to severe (score 4) overall rating for changes in body fat content and a total BFR score of ≥18.

Subjects were excluded if they had emotional distress or psychosis, unstable angina, shortness of breath with exercise, known medical history that would contraindicate exercise training, acute infections and opportunistic AIDS-defining illnesses. Subjects were also excluded if they had musculoskeletal or neuromuscular disorders or were unwilling to exercise continuously for ≥6 months. Out of 152 screened volunteers with BFR, 21 subjects did not have moderate or severe BFR, 16 were determined unfit to exercise, 11 declined to participate and four anticipated changes in medications that contraindicated exercise or had a neuromuscular disorder. One hundred HIV+ subjects with moderate to severe BFR were stratified by gender and randomised to either an EXS group ($n = 50$; BFR + EXS) or a no exercise (noEXS) control group ($n = 50$; BFR + noEXS).

Exercise protocol

BFR + EXS subjects participated in a 6-month supervised EXS programme (three sessions/ week, 1.5 h/session, alternating days) at a fitness club in Kigali. Subjects were instructed on proper warmup, stretching, and 15 min of brisk walking followed by 45–60 min of jogging, running, stair climbing, low-back and abdominal stabilisation and strengthening exercises. The EXS regimen was progressive. An instructor gradually encouraged subjects to perform primarily jogging and running exercises with a goal of achieving at least 45% age-predicted maximum heart rate in the first 3 weeks, 60% in the next 6 weeks, and 75% by the end of the EXS intervention. Subjects' heart rate was assessed daily during EXS, and EXS intensity was based on the age-predicted maximum heart rate in order to elicit an adequate stimulus for cardiorespiratory and musculoskeletal system adaptations. Each training session ended with 15-min cool down and stretching exercises. Subjects' attendance at each session was recorded, and nonadherence was defined as 50% missed training sessions. Cardiorespiratory fitness was assessed at baseline and 6 months later using a 20-min multistage shuttle-run test (20mMST) [19] to predict maximum oxygen consumption (VO_2 peak; ml/kg per min). The 20mMST assessment tool for cardiorespiratory fitness has been employed in health and fitness settings [20]. Each subject's cardiorespiratory fitness was assessed individually during the 20mMST to minimise possible sources of error, and their rating of perceived exertion was measured with the Borg Perceived Exertion Scale [14]. Two BFR + EXS subjects were lost from the study: one died following surgery, and another moved to a distant location. One BFR + noEXS subject was lost to follow-up. Adherence to the exercise programme was 82.2%. All measurements were obtained at baseline and after a 6-month observation or intervention period.

Quality-of-life assessments

Quality of life was measured at baseline and after 6 months using a short-form instrument (WHOQOL-BREF) [21] of the WHO Quality of Life HIV (WHOQOL-HIV), generically developed from international cross-cultural settings [22]. The WHOQOL-BREF evaluates overall general health and several other domains universally adopted from the WHOQOL-

HIV that evaluate QoL, namely, physical, psychological, independence and social relationship domains. However, as QoL for HIV+ patients during HAART may change due to the positive effects of HAART counterbalanced by the effects of BFR [4], we included an extra domain containing five facets specific for HIV+ patients receiving HAART. These items were generated from preliminary subjects' interviews, opinions of clinicians and social scientists working in the field of HIV/AIDS and a literature search [6, 9, 23]. These facets included feeling ashamed in public, problems of dressing style and clothes' size, feeling less confident about one's health, fear of HIV status being revealed by changes in body-fat distribution and being embarrassed due to body-fat changes. The 25-item WHOQOL-BREF instrument contained items asking how a person felt about different aspects of their life in the previous 4 weeks. The items were rated on a five-point Likert interval scale, where 1 indicated negative perceptions and feelings and 5 indicated very high positive perceptions and feelings. For example, an item on HIV disclosure asked, "In the last 4 weeks, how confident have you been about people knowing that you are HIV positive?" The available responses were: 1 (not at all), 2 (a little), 3 (a moderate amount), 4 (very much) and 5 (an extreme amount).

Anthropometric measurements

Height, weight, waist and hip circumferences were measured by two trained research associates while the subject was standing wearing light clothing and no shoes. Weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively. For reproducibility and to minimise interobserver variability, associates were trained on proper anatomic placement of the tape measure, and their measurements were cross-validated on a number of volunteer subjects before being allowed to take measurements from the study participants. Waist circumference was measured using a nonstretch cloth tape measure at the narrowest circumference halfway between the lowest ribs and iliac crests. Hip circumference was measured at the level of the anterior superior iliac spine, where this could be palpated, otherwise at the broadest circumference below the waist. Two measurements were taken, and if these differed by >2 cm, a third measurement was taken. The mean of the closest two measurements was used to calculate waist-to-hip ratio (WHR). An experienced investigator located and measured mid triceps, mid biceps, suprailiac and sub-scapular skin folds using Lange™ skin fold callipers. Measurements were read to the nearest 0.2 mm and averaged for each skin fold site. The sum of skin fold measures was used to predict percentage body fat (% BFM) using equations and formulas [24, 25] validated in a black population [26].

Statistical analyses

Categorical data were analysed using the chi-square test and where appropriate Fisher's exact test. Differences in group proportions were assessed using the test of two proportions procedure. The nonpaired Student *t* test was used to investigate differences between means for continuous variables with a normal distribution, and the Mann–Whitney rank sum test was used for data that was not normally distributed. For each domain, facet scores were calculated and mean scores for each domain presented. Domain scores were obtained by summing the facet scores in the respective domain and dividing by the number of facets in that domain and multiplying by 4, so that the score ranges were from 4 to 20. Lower scores indicated poorer self-perceived QoL for the assessed health measure. Analyses of covariance (ANCOVA) in which the 6-month change as the dependent variable (absolute change from baseline), treatment group as independent variable and baseline values as the covariates, were used to determine whether there were between-group differences in the assessed domains of QoL at 6 months. All analyses were performed using SAS software, version 9.1.3 of the SAS System for Linux (SAS Institute Inc., Cary, NC, USA). Significance was accepted at P value ≤0.05. Normally distributed data are expressed in the text and tables as mean ± standard deviation (SD), unless otherwise stated.

Results

Baseline data

Subjects were receiving predominantly WHO-recommended first-line HAART regimens with 80% receiving stavudine, lamivudine and nevirapine. Eleven percent of subjects were receiving zidovudine, lamivudine and nevirapine, 5% were on zidovudine, lamivudine and efavirenz, 3% were on stavudine, lamivudine and efavirenz and only 1% were on lamivudine, abacavir and nevirapine. The number of subjects on each of the five HAART regimens did not differ significantly between groups. Subjects' baseline demographic characteristics were not significantly different between groups (Table 1). The CD4 cell counts (cells/μl), HAART duration, body mass index (BMI), waist and hip circumferences, WHR and VO_2 peak (ml/kg per min) did not differ between BFR + EXS and BFR + noEXS subjects (Table 1).

Anthropometric changes and aerobic capacity after exercise training

After 6 months of exercise training, waist circumference and WHR significantly decreased in BFR + EXS compared with respective mean changes in BFR + noEXS subjects (Table 2). Following EXS, there was no significant difference in mean changes of hip circumference between BFR + EXS and BFR + noEXS subjects (Table 2). Exercise training resulted in a significant decline in the sum of skin folds, percent body fat and total BFR score in BFR + EXS subjects compared with BFR + noEXS subjects (Table 2). Furthermore, cardiorespiratory fitness improved more in the BFR + EXS [4.7 ± 3.9 vs. 0.5 ± 0.3 ml/kg per min; $P < 0.001$] than in BFR + noEXS subjects. Mean changes in CD4 cell count (cells/μl) were not significantly different between BFR + EXS and BFR + noEXS groups after 6 months (Table 2). In summary, 6 months of exercise training in BFR + EXS improved aerobic capacity and reduced body fat, waist circumference, BMI, sum of skin folds and BFR score.

Effects of exercise training on domains of quality of life

Over the 6-month period, there was a significant improvement in QoL measures in the BFR + EXS compared with BFR + noEXS subjects. In particular, significant improvements were observed in the BFR + EXS group for the psychological, independence, social relationships and HIV+ HAART-specific domains of QoL (Table 2). Specific improvements in psychological well-being were observed for self-esteem and satisfaction with social life ($P < 0.001$), body image and appearance ($P < 0.001$) and emotional stress ($P < 0.001$). Although the overall QoL domain improved in BFR + EXS group, we observed larger relative improvements in the psychological, independence, social relations and HIV HAART-specific domains of life (Table 2). For the HIV HAART-specific domain, BFR + EXS subjects reported fewer problems of feeling ashamed in public ($P < 0.0001$) and dressing style and size ($P < 0.0001$) and more confidence about their health ($P < 0.001$). Furthermore, BFR + EXS subjects reported less fear of forced HIV status disclosure ($P < 0.0001$) and were less embarrassed due to the impact of the body changes ($P < 0.0001$). We did not observe a significant difference in the changes in scores on the physical domain of QoL between the BFR + EXS and BFR + noEXS groups.

Changes in quality of life outcomes by gender

Within the BFR + EXS group, women improved more than men on the psychological domain ($P < 0.0001$) (Fig. 1), the social relationship domain of QoL ($P < 0.0001$) and the HIV HAART-specific domain of QoL ($P < 0.0001$). Conversely, women and men in the BFR + EXS group did not differ with respect to improvements in physical, independence and overall QoL domains. Also, female scores for the HIV HAART-specific domain of QoL declined more in the BFR + noEXS group than in the male gorup ($P < 0.05$) (Fig. 1).

Discussion

These findings suggest that 6 months of exercise training significantly improved QoL parameters in HAART-treated HIV+ Rwandan men and women with BFR without compromising immune function. To our knowledge, this is the first report on the benefits of exercise training on QoL in HAART-treated HIV+ African subjects with body fat alterations. Although it is difficult to entirely eliminate the possibility of contamination, cardiorespiratory fitness measured after 6 months of exercise training improved more in the exercise group than in the control group. Even if control subjects participated in some form of habitual exercise during the 6-month control period, it was of insufficient intensity and duration to improve their cardiorespiratory fitness.

From a psychosocial perspective, exercise training improved self-perception of the effects of BFR, enhanced psychological well-being and social relationships and ultimately improved the QoL for HAART-treated HIV-positive men and women with BFR. HIV+ women with BFR who exercised for 6 months experienced more significant improvements in the psychological and social relationships domains and reported significantly enhanced health confidence scores, whereas the changes in men with BFR in the BFR + EXS group were insignificant for these domains. Our findings underscore the potential benefits of exercise training to mitigate the effects of stigma, promote social relationships and improve patients' self-perception of HIV-status disclosure and contribute to HAART adherence and treatment initiatives. Participants in this study were not fully representative of the general HIV+ population receiving HAART, as these subjects had moderate to severe BFR. However, the prevalence of moderate to severe BFR in the Rwandan HIV+ population receiving HAART is 26.6% [27], and therefore, data from this study may be applicable to a large proportion of Rwandan subjects who are receiving HAART.

A high adherence to the exercise training programme was exhibited by the subjects in this study. Although further studies to assess the appropriateness and sustainability of such programmes in Rwanda and other countries with comparable cultural and social strata are warranted, the high adherence to exercise training may be attributed to the demand for interventions that attenuate HAART-associated BFR and provide psychological support and adequate interactions with health care professionals in subjects with severe BFR [4].

With the advent of effective HAART, HIV infection is now considered a chronic manageable illness, and QoL has therefore become an important issue, especially in HIV+ patients with body fat alterations. However, there are no validated instruments that assess the effects of body fat changes on QoL in a HAART-treated HIV population [28]. The instruments commonly used to assess QoL in HIV populations include the Medical Outcome Study Short Form 36 (MOS SF-36) [29], the HIV/AIDS-Targeted Quality of Life instrument (HAT-QoL) [30] and the Multidimensional Quality of life Questionnaire for HIV/AIDS (MQoL-HIV) [21]. As these instruments were tested in single cultural settings usually in the developed world, we assessed QoL using the WHOQOL-BREF [21], a short form of the WHOQOL-HIV instrument [22]. Available evidence suggests that the WHOQOL-HIV instrument is a reliable and valid measure of health-related QoL in patients with HIV infection [31], and it has been shown to be valid in multicultural settings of heterogeneous socioeconomic strata, including African countries [22].

Disparities in living conditions among HIV+ subjects with or without BFR may influence participants' QoL. However, there were no differences in demographic variables between the two study groups, with the principal occupational activities being agricultural, involving subsistence farming and the keeping of livestock. No data were collected with regard to housing conditions or access to clean drinking water and electricity. Furthermore, disparities in living conditions among HIV+ subjects with or without BFR may influence participants' QoL. However, most subjects lived within the neighbourhood of towns where they obtained adequate HIV treatment services. Their occupational activities were predominantly agricultural, being involved in routine subsistence peasantry farming, livestock and domestic animals such as poultry, goats, pigs, and sheep, and a few sold their produce to earn a living.

Few studies have examined the effects of an intervention on QoL in HIV+ people with body fat abnormalities [4]. We found that exercise training increased social interactions and improved psychological well-being in HIV+ men and women with body fat changes. Others have reported both the benefits of exercise training as a source of social support [32] or highlighted the importance of social support in coping with HIV disease [33]. Exercise training may have facilitated social interactions among participants, provided an opportunity for them to share experiences about the impact of body fat changes, and helped them regain a measure of control over disclosure of their health status. A study has shown that HAART-treated HIV-positive patients with morphologic changes perceived that health care providers neglected their psychosocial well-being, and they expressed dissatisfaction with physicians' psychological support [4]. This attitude may impede progress towards a meaningful, beneficial therapist–patient relationship, which is one of the major determinants of a high level of health-related QoL [34]. Therefore, exercise training could help to alleviate feelings of isolation, promote self-esteem and confidence in health and improve psychosocial constructs of well-being. This is of particular importance, as it may improve patients' attitudes and desire to commence or continue anti-HIV medications, particularly in sub-Saharan Africa where new treatment initiatives are being undertaken.

Exercise training improved functional independence and self-efficacy, possibly through improvements in cardiorespiratory fitness. Moreover, improvements in cardiorespiratory fitness were mirrored by a fall in the total BFR score in subjects who exercised over the 6-month study period. Others have shown that increases in fitness are associated with improvements in HIV+ patients' self-efficacy [35], and this may contribute towards better functional independence. Although exercise training has been shown to improve physical endurance, strength and cardiovascular function [36], studies on the effects of exercise training on QoL in HAART-treated HIV patients with body fat alterations are limited. However, improvements in QoL and aerobic fitness have been observed in HIV-positive patients following 6 weeks of exercise training [14]. Over a 6-month exercise intervention, although aerobic capacity improved in HIV+ patients with body fat alterations, we did not observe a significant improvement in perceived physical functioning parameters.

However, exercise training positively modulated anthropometric variables, resulting in a decline in central adiposity and a decrease in waist circumference and WHR without affecting hip circumference. HIV- and HAART-associated body fat alterations typically impair one's body image and appearance, and thus these positive morphologic adaptations following exercise training may have improved participants' psychological and social relationships and well-being due to an improved body image. Exercise training also improved subjects' psychosocial well being and self-perception of independence. Independence scores included questions regarding functional activities of daily living such as ability to engage in work, school and recreational activities. This is not surprising as the beneficial effects of exercise training on function and the ability to perform activities of daily living have been reported in other populations [37]. Contrary to our hypothesis, exercise training had no effect on subjects' perception of physical functioning. Improvement in independence may have influenced subjects' psychosocial well-being, as increased independence may have improved their ability to engage in social relationships. Another possible reason for improvement in psychosocial well-being could have been due to patients' self-perception of body image and self-esteem, which influenced mobility, social interactions and functioning more and thus influenced their perception of better independence. Indeed, others have reported that social support is a crucial factor in coping with the demands of functional limitations due to the psychosocial impact of HIV disease [33]. The physical functioning score included questions regarding energy, sleep, pain and discomfort. The reasons for lack of effect of exercise training on these parameters is unclear, as there are reports on the beneficial effects of exercise training on energy and fatigue in other populations. [38]. This may be due to the already high baseline values observed in the exercise group for perceived physical function (Table 2) and the nature of the questions used to measure the subject's perception of physical function, which did not include a direct question on physical fitness.

Although the QoL of both HIV+ men and women receiving HAART is equally affected by morphologic abnormalities [39], women appear to be at greater risk of developing body fat changes [40]. Our findings demonstrated that women's psychological well-being, social relationships and confidence about health improved more than they did for men. This is a significant finding because as with most other sub-Saharan countries, women comprise the majority of HIV+ patients receiving HAART in Rwanda [41]. Thus, exercise training is especially beneficial for HAART-treated HIV+ women and seems to attenuate symptoms that may adversely affect medication adherence [42]. The reasons this intervention was more effective in women than in men are not known, and this study was not designed to address this issue. However, women may have greater sensitivity and perception of changes in body shape and image, which resulted in greater self-esteem and improved QoL when compared with men [43].

Our study has some limitations. First, although HIV and HAART-specific measures of QoL chosen for this study are important for the breadth and multidimensional conceptual framework and are specifically sensitive for HIV+ subjects with body fat alterations during the HAART era, they are in the process of being validated in other studies [23]. Second, subjects were recruited from public government hospitals and HIV/AIDS clinics and were all on WHO-recommended HAART and therefore do not necessarily represent the general national population of HIV+ patients receiving HAART. Third, we did not assess dietary intake in our study population, so we cannot ascertain to what extent the differences observed in anthropometric changes between the two study groups were due to differences in diet.

The findings support the notion that supervised exercise training may potentially moderate the effects of body fat changes that impair body image and self-esteem and result in marginalisation and stigmatisation of HAART-treated HIV+ African men and women. Participants underwent inexpensive and simple but guided and effective aerobic exercise training in which cardiorespiratory fitness significantly improved more in subjects who exercised for 6 months. This is the first study to exhibit improvements in QoL for HAART-treated HIV-positive African subjects with BFR. Evidence suggests that lifestyle modifications including exercise training are beneficial for HAART-treated HIV-positive subjects with body fat alterations from Western countries [44, 45]. However, to make such exercise programmes more accessible in resource-poor environments, subjects with BFR should be enrolled into home-based exercise programmes that have proven beneficial to HIV-positive subjects in developed countries [46]. Exercise training may prevent deterioration of psychological factors and social relationships in HIV-positive men and women receiving or starting HAART treatment. One important strategy would be to promote inexpensive and efficacious interventions, such as exercise training, along with other behavioural interventions, with the goal of improving HAART adherence and treatment initiatives, particularly in resource-limited areas of sub-Saharan Africa.

Acknowledgments

We thank the participants in the study for their valuable time and commitment. We acknowledge the support of Kigali Health Institute administration; research associates, particularly David Tumusiime; and the hospital administrative staff from where the subjects were recruited. We thank the Commission Nationale de Lutte Contre le SIDA (CNLS) and Multi-Sectorial AIDS Program (MAP), Rwanda for funding this study. This work was part of the requirements approved by University of the Witwatersrand, Johannesburg, for the award of the degree of doctor of philosophy (Ph.D.) to Eugene Mutimura. KEY was supported by NIH grants DK49393, DK59531, AT03083, DK56341, and RR00954. WTC was supported by NIH grant KDK074343A.

References

1. Egger M, May M, Chene G, et al. Prognosis of HIV-1-infected patients starting highly active antiretroviral therapy: a collaborative analysis of prospective studies. Lancet. 2002; 360:119–129. [PubMed: 12126821]
2. Chen D, Mistra A, Garg A. Lipodystrophy in human immunodeficiency virus-infected patients. The Journal of Clinical Endocrinology and Metabolism. 2002; 87:4845–4856. [PubMed: 12414837]
3. Pujari SN, Dravid A, Naik E, et al. Lipodystrophy and dyslipidaemia among patients taking first-line, World Health Organisation-recommended highly active antiretroviral therapy regimens in Western India. Journal of Acquired Immune Deficiency Syndromes. 2005; 39:199–202. [PubMed: 15905737]
4. Reynolds NR, Neidig JL, Wu AW, et al. Balancing disfigurement and fear of disease progression: Patient perceptions of HIV fat redistribution. AIDS Care. 2006; 18:663–673. [PubMed: 16971273]
5. Beck EJ, Vitoria M, Mandalia S, et al. National adult antiretroviral therapy guidelines in resource-limited countries: Concordance with 2003 WHO guidelines? AIDS. 2006; 11:1497–1502. [PubMed: 16847404]
6. Ammassari A, Antinori A, Cozzi-Lepri A, et al. Relationship Between HAART Adherence and Adipose Tissue Alterations. Journal of Acquired Immune Deficiency Syndromes. 2002; 31:S140–S144. [PubMed: 12562038]
7. Tramarin A, Campostrini S, Postma MJ, et al. A multicentre study of patient survival, disability, quality of life and cost of care: Among patients with AIDS in northern Italy. Pharmacoeconomics. 2004; 22:43–53. [PubMed: 14720081]
8. Steel JL, Landsittel D, Calhoun B, et al. Effects of lipodystrophy on quality of life and depression in HIV-infected men on HAART. AIDS Patient Care and STDs. 2006; 20:565–575. [PubMed: 16893326]
9. Blanch J, Rousaud A, Martinez E, et al. Factors associated with severe impact of lipodystrophy on quality of life of patients infected with HIV-1. Clinical Infectious Disease. 2004; 38:1464–1470.
10. Jacobson DL, Knox T, Spiegelman D, et al. Prevalence of, evolution of, and risk factors for fat atrophy and fat deposition in a cohort of HIV-infected men and women. Clinical Infectious Disease. 2005; 40:1837–1845.
11. Wohl DA. Diagnosis and management of body morphology changes and lipid abnormalities associated with HIV Infection and its therapies. Topics in HIV Medicine. 2004; 12:89–93. [PubMed: 15310940]
12. Dube MP, Stein JH, Aberg JA, et al. Guidelines for the evaluation and management of dyslipidemia in human immunodeficiency virus (HIV)-infected adults receiving antiretroviral therapy: Recommendations of the HIV Medicine Association of America and the Adult AIDS Clinical Trials Group. Clinical Infectious Disease. 2003; 37:613–627.
13. Ciccolo JT, Jowers EM, Bartholomew JB. The benefits of exercise training for quality of life in HIV/AIDS in the post-HAART era. Sports Medicine. 2004; 34:487–499. [PubMed: 15248786]
14. Stringer WW, Berezovskava M, O'Brien WA, et al. The effects of exercise training on aerobic fitness, immune indices, and quality of life in HIV positive patients. Medicine and Science in Sports and Exercise. 1998; 30:11–16. [PubMed: 9475639]

15. Bartholomew JB, Miller BM. Affective responses to an aerobic dance class: the impact of perceived performance. Research Quarterly for Exercise and Sport. 2002; 73:301–309. [PubMed: 12230337]
16. Burnham TR, Wilcox A. Effects of exercise on physiological and psychological variables in cancer survivors. Medicine and Science in Sports and Exercise. 2002; 34:1863–1867. [PubMed: 12471288]
17. Lichtenstein KA, Ward DJ, Moorman AC. Clinical assessment of HIV-associated lipodystrophy in an ambulatory population. AIDS. 2001; 15:1389–1398. [PubMed: 11504960]
18. Carr A, Emery S, Law M, et al. An objective case definition of lipodystrophy in HIV-infected adults: A case-control study. Lancet. 2003; 361:726–735. [PubMed: 12620736]
19. Wilkinson DM, Fallowfield JL, Myers SD. A modified incremental shuttle run test for the determination of peak shuttle running speed and the prediction of maximal oxygen uptake. Journal of Sports Sciences. 1999; 17:413–419. [PubMed: 10413269]
20. Flouris AD, Metsios GS, Koutedakis Y. Enhancing the efficacy of the 20 m Multi-stage run test. British Journal of Sports Medicine. 2005; 39:166–170. [PubMed: 15728698]
21. Hsiung P, Fang C, Chang YY, et al. Comparison of WHOQOL-BREF and SF-36 in patients with HIV infection. Quality of Life Research. 2005; 14:141–150. [PubMed: 15789948]
22. O'Connell K, Saxena S, Skevington S, et al. WHOQOL-HIV Quality of Life assessment among people living with HIV and AIDS: results from the field test. AIDS Care. 2004; 16:882–889. [PubMed: 15385243]
23. Guaraldi G, Orlando G, Murri R, et al. Quality of life and body image in the assessment of psychological impact of lipodystrophy: Validation of the Italian version of Assessment of Body Change and Distress questionnaire. Quality of Life Research. 2006; 15:173–178. [PubMed: 16411042]
24. Durnin JVGA, Rahaman MM. The assessment of the amount of fat in the human body from measurements of skinfold thickness. The British Journal of Nutrition. 1967; 21:681–689. [PubMed: 6052883]
25. Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16–72 years. The British Journal of Nutrition. 1974; 32:77–97. [PubMed: 4843734]
26. Zillikens MC, Conway JM. Anthropometry in blacks: Applicability of generalized skinfold equations and differences in fat patterning between blacks and whites. The American Journal of Clinical Nutrition. 1990; 52:45–51. [PubMed: 2360551]
27. Mutimura E, Stewart A, Rheeder P, et al. Metabolic function and the prevalence of lipodystrophy in a population of HIV-infected African subjects receiving highly active antiretroviral therapy (HAART). Journal of Acquired Immune Deficiency Syndromes. 2007; 46:451–455. [PubMed: 18077834]
28. Liu C, Ostrow D, Detels R, et al. Impacts of HIV infection and HAART use on quality of life. Quality of Life Research. 2006; 15:941–949. [PubMed: 16900275]
29. Holmes WC, Shea JA. Performance of a new HIV/AIDS-targeted quality of life (HAT-QoL) instrument in asymptomatic seropositive individuals. Quality of Life Research. 1997; 6:561–571. [PubMed: 9330555]
30. Smith KW, Avis NE, Mayer KH, Awislow L. Use of the MQoL-HIV with asymptomatic HIV-positive patients. Quality of Life Research. 1997; 6:555–560. [PubMed: 9330554]
31. Kuyken W, Orley J, Sartorius N, Power M, Herrman H, Schofield H. WHO Group. The World Health Organisation Quality of life Assessment (WHOQOL): Position paper from the World Health Organisation. Social Science and Medicine. 1995; 41:1403–1409. [PubMed: 8560308]
32. Galantino ML, Shepard K, Krafft L, et al. The effect of group aerobic exercise and t'ai chi on functional outcomes and quality of life for persons living with acquired immunodeficiency syndrome. Journal of Alternative and Complementary Medicine. 2005; 11:1085–1092.
33. Burgoyne R, Renwick R. Social support and quality of life over time among adults living with HIV in the HAART era. Social Science and Medicine. 2004; 58:1353–1366. [PubMed: 14759681]

34. Preau M, Leport C, Salmon-Ceron D, et al. Health-related quality of life and patient-provider relationships in HIV-infected patients during the first three years after starting PI-containing antiretroviral treatment. AIDS Care. 2004; 16:649–661. [PubMed: 15223534]
35. Fillipas S, Oldmeadow LB, Bailey MJ, et al. A six-month, supervised, aerobic and resistance exercise program improves self-efficacy in people with human immunodeficiency virus: A randomized controlled trial. The Australian Journal of Physiotherapy. 2006; 52:185–190. [PubMed: 16942453]
36. Scevola D, Di Matteo A, Lanzarini P, et al. Effect of exercise and strength training on cardiovascular status in HIV-infected patients receiving highly active antiretroviral therapy. AIDS. 2003; 17:123–129. [PubMed: 12478079]
37. Korzeniowska-Kubacka I, Bilińska M, Piotrowicz R. Influence of physical training on cardiac performance in patients with coronary artery disease and exercise-induced left ventricular dysfunction. Acta Cardiologica. 2007; 62:573–578. [PubMed: 18214122]
38. O'Connor PJ, Puetz TW. Chronic physical activity and feelings of energy and fatigue. Medicine and Science in Sports and Exercise. 2005; 37:299–305. [PubMed: 15692327]
39. Nicholas PK, Kirksey KM, Corless IB, et al. Lipodystrophy and quality of life in HIV: Symptom management issues. Applied Nursing Research. 2005; 18:55–58. [PubMed: 15812737]
40. Galli M, Veglia F, Angarano G, et al. Gender differences in antiretroviral drug-related adipose tissue alterations. Women are at higher risk than men to develop particular lipodystrophy patterns. Journal of Acquired Immune Deficiency Syndromes. 2003; 34:58–61. [PubMed: 14501794]
41. Kayirangwa E, Hanson J, Munyakazi L, et al. Current trends in Rwanda's HIV/AIDS epidemic. Sexually Transmitted Infections. 2006; 82:27–31.
42. Corless IB, Kirksey KM, Kemppainen J, et al. Lipodystrophy-associated symptoms and medication Adherence in HIV/AIDS. AIDS Patient Care and STDs. 2005; 19:577–586. [PubMed: 16164384]
43. Connors J, Casey P. Sex, body-esteem and self-esteem. Psychological Reports. 2006; 98:699–704. [PubMed: 16933665]
44. Jones SP, Doran D, Leatt PB, et al. Short-term exercise training improves body composition and hyperlipidaemia in HIV-positive individuals with lipodystrophy. AIDS. 2001; 15:2049–2051. [PubMed: 11600837]
45. Fitch K, Anderson EJ, Hubbard JL, et al. Effects of a lifestyle modification program in HIV-infected patients with metabolic syndrome. AIDS. 2006; 20:1843–1850. [PubMed: 16954725]
46. Dolan SE, Frontera W, Librizzi J, et al. Effects of a supervised home-based aerobic and progressed resistance regimen in women infected with human immunodeficiency virus. Archives of Internal Medicine. 2006; 166:1225–1231. [PubMed: 16772251]

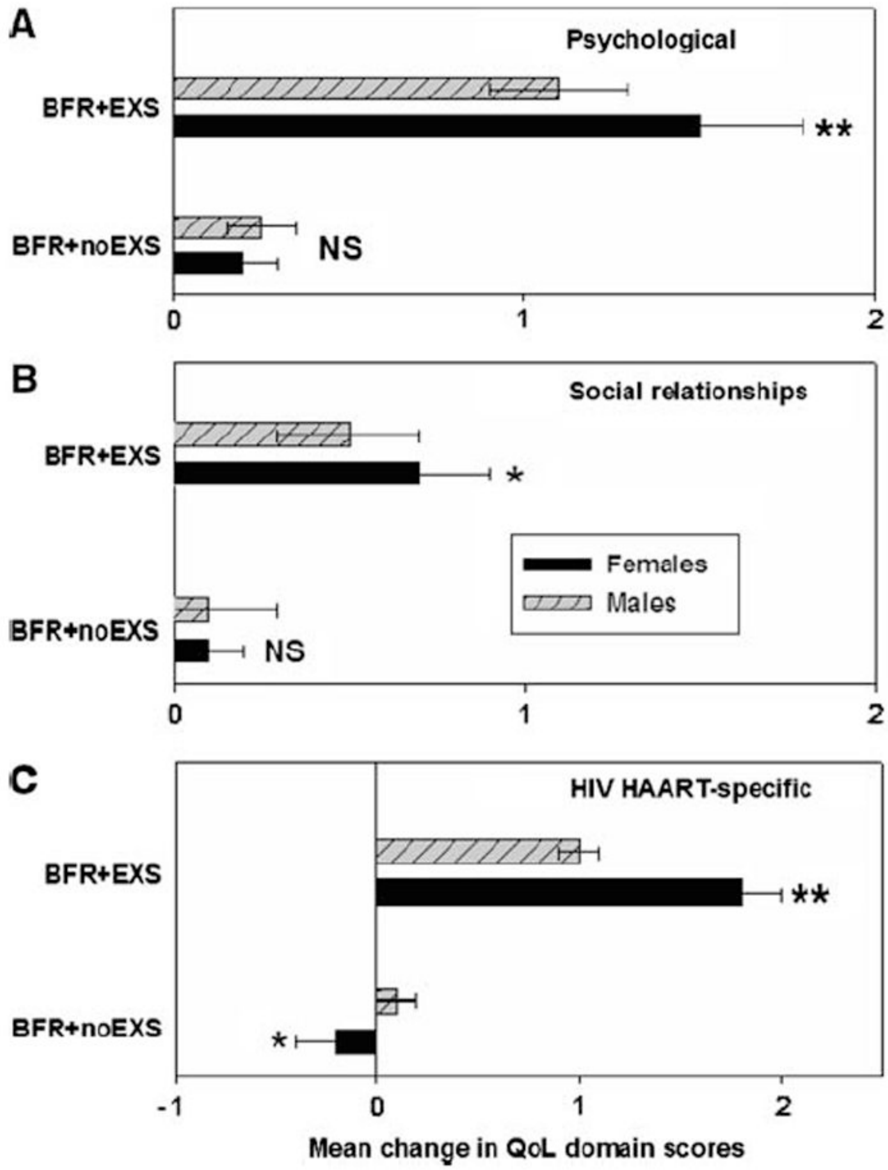

Fig. 1.

Quality of life mean domain score changes at 6 months by gender; data expressed as mean ± standard deviation. * $P < 0.05$, ** $P < 0.0001$ versus male group

Table 1

Baseline characteristics and body composition

	BFR + noEXS	BFR + EXS	*P* value
Number (% women)	50 (60)	50 (60)	–
Age (years)	37.5 ± 6.9	37.8 ± 5.5	0.81
Education			0.67
≤Secondary (high) school	21 (42)	18 (36)	
Secondary (high) school	29 (58)	32 (64)	
Tertiary (college) education	–	–	
Occupation			0.86
Public service or private	7 (14)	6 (12)	
Farming or livestock	27 (54)	28 (56)	
Self-employed	10 (20)	8 (16)	
Unemployed	6 (12)	8 (16)	
No. of years known to be HIV+			0.57
≤4 years	9 (18)	5 (10)	
5–10 years	25 (50)	32 (64)	
≥11 years	16 (32)	13 (26)	
Smoking			0.37
Yes	10 (20)	7 (14)	
No	40 (80)	43 (86)	
Marital status			0.83
Married	9 (18)	12 (24)	
Separated	6 (12)	3 (6)	
Widow or widower	24 (48)	25 (50)	
Cohabiting	11 (22)	10 (20)	
CD4 cell count (cells/μl)	348 ± 162	353 ± 168	0.29
HAART duration (weeks)	63 ± 28	71 ± 37	0.23
BFR Score $_{(7\text{-item})}$	18.7 ± 2.3	19.3 ± 2.1	0.18
VO_2 peak (ml/kg/min)	23.9 ± 2.9	24.3 ± 3.8	0.56
Body composition			
BMI (kg/m^2)	24.4 ± 2.7	24.0 ± 3.1	0.49
Waist (cm)	92.3 ± 6.9	91.0 ± 8.4	0.40
Hip (cm)	93.7 ± 6.8	92.3 ± 7.6	0.33
Waist-to-hip ratio	0.98 ± 0.0	0.99 ± 0.1	0.48
Sum skin folds	62.7 ± 12.9	62.3 ± 15.0	0.89
Body fat mass (%)	29.3 ± 4.3	29.4 ± 6.2	0.93

Data expressed as mean ± standard deviation or number (%)

HAART highly active antiretroviral therapy, *BFR* body fat redistribution, *EXS* exercise training, *noEXS* no exercise training, *VO_2* peak maximum oxygen consumption, *BMI* body mass index

Table 2

Baseline and mean changes between groups for main outcome measures after 6 months of exercise training

	BFR + noEXS		BFR + EXS		*P* value
	Baseline	**Changes at 6 months**	**Baseline**	**Changes at 6 months**	
Number (women)	50 (60%)	49 (61%)	50 (60%)	48 (63%)	–
CD4 cell count (cells/μ1)	348 ± 162	44 ± 18	353 ± 168	19 ± 13	0.54
BFR score $_{(7\text{-item})}$	18.7 (2.3)	0.51 (1.3)	19.3 (2.1)	−4.7 (0.9)	<0.0001
BMI (kg/m^2)	24.5 ± 0.4	0.1 ± 0.1	24.0 ± 0.1	−0.53 ± 0.2	<0.05
Waist circumference (cm)	92.3 ± 6.9	0.03 ± 10.7	91.0 ± 8.4	−7.13 ± 4.4	<0.0001
Hip circumference (cm)	93.7 ± 6.8	0.22 ± 0.7	92.3 ± 7.6	1.13 ± 5.4	0.19
WHR	0.98 ± 0.0	0.00 ± 0.1	0.99 ± 0.1	−0.10 ± 0.1	<0.0001
Triceps (mm)	14.4 ± 3.4	−0.2 ± 0.7	14.4 ± 3.9	−1.42 ± 2.1	<0.0001
Biceps (mm)	10.8 ± 2.4	−0.1 ± 0.3	10.7 ± 2.5	−0.63 ± 1.6	0.0001
Subscapular (mm)	18.7 ± 4.5	−0.6 ± 1.7	18.6 ± 5.2	−1.9 ± 3.2	0.0001
Suprailiac (mm)	18.8 ± 5.1	−0.4 ± 1.4	18.7 ± 5.5	−2.1 ± 3.5	<0.0001
Sum of 4 skin folds (mm)	61.2 ± 1.7	−1.25 ± 0.5	62.3 ± 2.1	−6.15 ± 1.2	<0.0001
Body fat mass (%)	29.3 ± 0.6	−0.16 ± 0.1	29.4 ± 0.9	−1.5 ± 0.5	<0.0001
VO_2 max (ml/kg/min)	23.9 ± 2.9	0.5 ± 0.3	24.3 ± 3.8	4.7 ± 3.9	<0.0001
QoL domain scores					
Physical	17.2 (0.4)	0.0 (0.1)	16.9 (0.7)	0.2 (0.1)	0.57
Psychological	11.0 (0.3)	0.5 (0.1)	11.1 (0.5)	1.3 (0.3)	<0.0001
Independence	17.6 (0.7)	0.0 (0.0)	17.5 (0.6)	0.6 (0.1)	<0.0001
Social relationships	9.0 (0.5)	0.0 (0.0)	9.2 (0.5)	0.6 (0.2)	<0.0001
HIV HAART-specific	4.7 (0.6)	−0.1 (0.2)	4.7 (0.4)	1.4 (0.2)	<0.0001
Overall QoL	15.5 (1.1)	0.0 (0.3)	15.6 (0.7)	0.5 (0.3)	<0.05

EXS exercise training, *noEXS* no exercise training, *BFR* body fat redistribution, BMI body mass index, WHR waist-to-hip ratio, *VO_2 max VO_2* maximum oxygen consumption, *QoL* quality of life, *HAART* highly active antiretroviral theraphy, *ANCOVA* analysis of covariance

Data expressed as mean ± standard deviation or median (interquartile range). Differences between BFR + EXS and BFR + noEXS group changes after 6 months of exercise training expressed after adjustment for baseline values using ANCOVA