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The Benefits of Exercise Training for Quality of Life in HIV/AIDS in the Post-HAART Era

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Abstract

The use of highly active antiretroviral therapy (HAART) has served to significantly reduce the mortality of HIV-infected persons. However, this treatment is associated with a host of adverse effects: fatigue, nausea, pain, anxiety and depression. Rather than utilise traditional pharmacological treatments for these effects, many HIV/AIDS patients are utilising adjunct therapies to maintain their quality of life while they undergo treatment. Exercise has consistently been listed as one of the most popular self-care therapies and a small number of studies have been conducted to examine the impact of exercise on the most common self-reported symptoms of HIV and AIDS and the adverse effects of treatment. Although the results are generally positive, there are clear limitations to this work. The existing studies have utilised small samples and experienced high rates of attrition. In addition, the majority of the studies were conducted prior to the widespread use of HAART, which limits the ability to generalise these data. As a result, data from other chronic disease and healthy samples are used to suggest that exercise has the potential to be a beneficial treatment across the range of symptoms and adverse effects experienced by HIV-infected individuals. However, additional research is required with this population to demonstrate these effects.

The development of highly active antiretroviral therapy (HAART) has revolutionised the treatment of HIV, significantly lessoning the mortality and opportunistic infections in both HIV-infected inpatients and outpatients.[1-4] As a result, HIV infection is now treated as a chronic illness, despite the fact that it remains a life-threatening disease. Unfortunately, treating HIV with HAART results in a number of physical and psychological adverse effects. Common physical adverse effects include disorders of the nervous system (headache, pain/neuropathy, and fatigue), gastrointestinal tract (nausea, vomiting and diarrhoea), integumentary system (rash, dry skin), metabolic processes (glucose, lipid alterations and bone disease) and morphology (lipodystrophy, lipidatrophy).[5] There are also neuropsychiatric adverse effects due to HAART and/or the HIV infection. These are particularly problematic in that they can be compounded by a negative psychological response to the physical adverse effects listed above. These psychological responses may include agitation, confusion, anxiety, nightmares, hallucinations, mania and depression.[6] Thus, although HAART allows for a reduction in HIV-related mortality, the extension in a patient's length of life can be associated with a reduction in their quality of life. As such, it

is increasingly more important to develop interventions for this population that are designed to enhance their quality of life.

Although many of these effects are treatable with pharmacological agents, it is not practical to rely on additional medications to achieve this effect. Utilising HAART requires HIV-infected individuals to follow a strict protocol guiding the ingestion of numerous pills. As a result, dosing schedules and pill burden are regularly reported as constraining factors in adherence to HAART.[7-11] Furthermore, adherence to the prescribed dose of protease inhibitors of a rate less than 95% has been reported to provide significantly lower viral suppression.[12] Thus, the addition of yet another pill to treat the adverse effects of HIV and HAART is likely to further compromise the benefits of HAART. It may be that HIV-infected patients could instead benefit from alternative forms of medicine as an adjunct to their HIV treatments. In the US, 30–80% of this population report the use of complementary and alternative therapies.[13] Exercise is consistently listed among the three most common complementary and alternative therapies utilised by HIV-infected persons.[14-16] It is, therefore, reasonable to expect HIV-infected persons to utilise exercise as a strategy to cope with the symptoms of HIV and HAART. At question is the efficacy of this approach. Through this review, we will detail the evidence that exercise may be successfully used to manage the most common self-reported symptoms of HIV/AIDS and the adverse effects of HAART, as well as to indicate the directions that this research might take to maximise these benefits.

1. Symptoms of HIV/AIDS and Adverse Effects of Highly Active Antiretroviral Therapy (HAART)

1.1 The Pre-HAART Era

Much of the early research with HIV-infected individuals focused on the self-reported physical and psychological symptoms. For example, fatigue, anorexia, wasting, cough, pain, night sweats and fever[17-21] were cited as the most common physical symptoms. These were reported along with the psychological effects of anxiety, worrying, fear, depression and sadness.[17,18] For instance, symptoms of anxiety and depression were singled out in pre-HAART studies as highly prevalent, with one study citing almost 80% of HIV-infected patients reporting depression and anxiety.[6] Pain was found to be a major contributor to the lower quality of life experienced by HIV-infected individuals in the pre-HAART era,[22] with one study of 252 patients reporting 20% with asymptomatic neuropathy and 35% with symptomatic neuropathy.[23] Fatigue was also a pervasive symptom cited by HIV-infected patients in the pre-HAART era. In fact, the incidence of fatigue was consistently reported as greater than 50% in the HIV/AIDS populations.[17,19,24-27] Breitbart, et al.[24] found that of 427 AIDS patients, 52.7% reported fatigue, and that fatigue was associated with a greater number of AIDS-related symptoms. This was replicated in a study that found fatigue to be linked to depressed mood, major depressive disorder and physical limitations.[28] As a result, fatigue was identified as the symptom causing the most distress in HIV-infected individuals in the pre-HAART era.[29]

1.2 The Post-HAART Era

Currently, it is estimated that 84% of Americans who are diagnosed with HIV utilise HAART.[30] Although some of the symptoms have decreased in prevalence and severity in conjunction with HAART, several are persistent. For instance, a recent study of 484 HIV-infected (non-AIDS) individuals found that fatigue (43%), insomnia (35%), anxiety (34%) and pain (31%) were the most commonly experienced symptoms despite the participants' use of HAART.[31] Other symptoms included muscle aches, dry skin, headaches, numbness, poor appetite and troubled breathing. Likewise, Corless et al.[32] asked 422 HIV-infected (non-AIDS and AIDS) participants to list their most common symptoms. Anxiety was found to be the most prevalent symptom, followed by diarrhoea, pain, nausea and vomiting, depression and fatigue. Although this study did not cite an independent effect for taking antiretroviral

medication on symptoms experienced, 75% of the sample reported taking antiretroviral medication. Thus, it appears that while certain symptoms (e.g. wasting, cough) have decreased in the post-HAART era, several others such as fatigue, pain, anxiety and depression remain.

These persistent symptoms of HIV are compounded by the adverse effects that are specific to the use of HAART. These may include nausea and vomiting, diarrhoea, skin rashes, anaemia, fat redistribution and neuropathy.[33] More problematic is that the adverse effects that are specific to HAART are known to cause severe distress and disruption to the mental health of HIV-infected individuals. In fact, in a survey done by the International Association of Physicians in AIDS Care it was found that 83.6% of physicians believe that the most common psychiatric symptoms were not a direct result of the disease but were, instead, due to the use of antiretroviral drugs.[6]

Although some antiretroviral medications are known to directly increase depressive moods and anxiety, in many cases it may be that these negative psychological responses are instead due to a reaction to the adverse effects of HAART. For instance, the severity of nausea accompanying HAART can range from mild distress to a degree of disruption that limits function, causes dehydration and reduces medication adherence.[34-36] It is, therefore, not surprising that the individuals who experience more severe adverse effects would also experience negative psychological responses, like anxiety and depression, in response to these adverse effects. Likewise, common symptoms of pain (headache, muscle cramps/aches and peripheral neuropathy) have been cited as major contributors to the lower functional quality of life experienced by HIV-infected individuals.[37] In addition, Sullivan et al.[38] found that 39% of individuals prescribed at least one nucleoside reverse transcriptase inhibitor had fatigue; and similar to other reports, fatigue was found to be associated with depression.[39] Finally, a recent study of 2258 HIV-infected men and women found that adipose tissue alterations (ATAs) were present in 29.5% of the men and 41.9% of the women.[40] The presence of ATAs, for which there is currently no known effective treatment, negatively impact self-image, self-esteem, social functioning and bodily comfort.[41,42] Moreover, individuals with ATAs often experience anxiety and depression and have been shown to decrease their medication adherence.[42] It is, therefore, clear that the more severe physical adverse effects of HAART are associated with negative psychological responses.

The current experience of the HIV-infected individual is surely different from that of the pre-HAART era. Although recent advances in treatment for HIV have resulted in increased survivorship rates, these treatments are associated with distressing adverse effects that compromise quality of life. Thus, while their lives are extended, symptom and adverse effect management has become a primary concern. Fatigue, pain, anxiety and depression pose consistent physical and psychological challenges to these individuals. We believe that exercise may serve as an alternative or adjunct therapy to assist in the management of this chronic disease. Although data for this population are sparse, section 2 will examine the evidence that exercise has the potential to effectively treat a wider array of the symptoms and adverse effects than has been examined in the HIV-infected population to date.

2. Exercise and Other Populations

The benefits of exercise training for fatigue, dyspnoea, pain, nausea, anxiety, depression and quality of life have all been examined in the exercise literature, often with respect to a particular chronic disease. Most frequently, these data have been derived from a lasting, e.g. 10- to 12-week, exercise training programme. However, the effects of HIV and HAART are likely to serve as barriers to ongoing exercise participation. As a result, particular note will be made of the benefits that are derived from short, single bouts of exercise as these effects might be especially useful for this population.

Various populations including patients with cancer, cardiovascular disease, chronic fatigue syndrome, Hodgkins disease and fibromyalgia have reported aerobic exercise as an effective method to

treat fatigue.[43-54] Multiple studies have shown mild to moderate exercise to be a highly effective strategy to reduce fatigue in cancer patients.[46,49-53] Reductions in fatigue have also been consistently reported in cardiovascular disease, fibromyalgia and chronic fatigue syndrome with aerobic exercise.[43,44,47,54] In general, these programmes have consisted of 8–12 weeks of aerobic activity, 3–5 days/week, at 60–85% maximal heart rate (HR_{max}). In addition, it has long been recognised that a single bout of aerobic exercise is sufficient to reduce fatigue and increase vigour in healthy individuals.[55] This is an effect that has been shown to occur with as little as a 10-minute brisk walk.[56]

Research with chronic obstructive pulmonary disease (COPD) patients has shown aerobic exercise to be an effective treatment for decreasing dyspnoea. In fact, Gimenez et al.[57] concluded that utilising a high-intensity endurance training programme (alternating between 1-minute at peak oxygen consumption [$\dot{V}O_{2peak}$] and 4 minutes at 40% $\dot{V}O_{2peak}$) would provide the largest benefit. Participants in this study were found to improve their breathlessness and reduce dyspnoea after exercising 5 days a week for 6 weeks. Other studies have shown similar reductions with regular aerobic exercise training (e.g. 8–12 weeks) such as that done with pulmonary rehabilitation.[58-60]

Currently, exercise has been cited as a potential analgesic for different types of pain;[61-66] however, the specific exercise programme that is required to produce a hypoanalgesic response has yet to be determined.[65] For example, Bartholomew et al.[63] found a significant increase in pain tolerance following a single 20-minute bout of exercise in college students, while Busch et al.[66] has shown long-term exercise training to be an effective pain reducer in fibromyalgia patients. Busch et al.[66] reported on four studies showing significant improvements in tender point pain pressure threshold (28.1%) and improvements in felt pain (11.4%) following an exercise programme. Because fibromyalgia patients experience similar chronic musculoskeletal pain (aching and cramping), this type of pain management appears to be a potentially fruitful area for research with HIV-infected patients.

We are aware of only one study that has been conducted to examine the use of exercise as a treatment for nausea. Winningham and MacVicar[67] reported decreases in nausea in breast cancer patients undergoing chemotherapy when compared with placebo and control groups. Participants exercised on a cycle ergometer for 10 weeks, three times per week at a moderate intensity. Considering that HIV/AIDS and cancer patients experience similar treatment symptoms, it is plausible that this effect could be replicated in the HIV/AIDS population. Thus, exercise may serve as a means to lesson nausea; however, it is important to acknowledge that any benefit may be impacted by exercise intensity and the surrounding environment. Intense exercise, particularly when completed in warm surroundings, has been shown to result in nausea in healthy individuals.[68,69] Therefore, particular care must be shown in testing this effect with HIV-infected persons, specifically in those who are just beginning HAART.

With regard to anxiety and depression, exercise has been shown to be a useful treatment for a wide range of chronic disease populations. These include patients with cardiovascular disease, breast cancer, diabetes mellitus, COPD, fibromyalgia and multiple sclerosis.[70-80] Specifically, cardiac rehabilitation has been shown to decrease depression and anxiety.[75] Breast cancer patients exercising 4 days/week, for 10 weeks at >60% of age-predicted HR_{max}, for 30–40 minutes were also found to have significant decreases in anxiety and depression.[71] Reductions in anxiety were also seen in breast cancer patients after just 15 minutes of moderate-intensity aerobic cycling.[79] Exercise training has been associated with improvements in mood for fibromyalgia patients,[76] decreases in anxiety in COPD,[77] decreases in depression and anger in multiple sclerosis[74] and increases in quality of life for patients with diabetes.[78]

Exercise has not only been reported to reduce negative psychological states, but also to improve an array of positive states.[81] In fact, there is growing evidence that exercise is sufficient to increase posi-

tive mood state, vigour/energy and positive well-being.[80-83] For example, it has been shown that exercise provides increases in positive mood state in healthy individuals,[81] increases in vigour/energy in cancer populations[80] and, most recently, increases in positive well-being in persons with spinal cord injuries.[83]

Thus, the data are clear that exercise can be utilised to regulate negative physical, and negative/positive psychological states in a wide range of both healthy and diseased populations. Lasting exercise training has been shown to reduce a wide array of symptoms: fatigue, pain perception, dyspnoea, nausea, anxiety and depression, and has done so across a range of healthy and diseased populations. Given the consistency of these effects across varied populations, there is great hope that exercise training will have a similar effect in the HIV-infected population. In contrast, the benefits of single bouts of exercise have been less well studied, particularly in individuals with a chronic disease. Within healthy samples, single exercise sessions have been shown to reduce fatigue, anxiety, depressive moods and to increase pain tolerance, vigour, positive mood state and well-being.[81,82] More data are required across numerous chronic disease populations before short-term exercise can be recommended as strategy to regulate these states.

The optimism that HIV-infected persons will react in a similar fashion is derived from two bodies of research. As will be presented in section 3, HIV-infected individuals respond physically to exercise in a similar manner as those from other populations. There is an extensive literature base that indicates that this population responds to exercise training with the expected increases in fitness. In addition, as will be presented in section 3, results are positive from the little research that has examined the ability of exercise to manage the symptoms and adverse effects of treatment in HIV/AIDS patients.

3. Exercise Training and HIV/AIDS

An electronic database literature search was conducted using PubMed, PsychInfo and the Web of Science (ISI Web of Knowledge) limiting the publication date to all those items published prior to October, 2003. Any literature relevant to aerobic or resistance exercise and its physical and psychological effects on the HIV-infected population was included. Of these, the vast majority of the research done with this population occurred in the pre-HAART era. At a time when wasting was a primary concern, the exercise research centred on issues of safety, efficacy and physiological adaptation. As a result, the first studies were designed to determine if HIV/AIDS patients were fully capable of completing and adapting to various intensities of exercise. In the earliest studies, the primary independent variable had been the presence of aerobic or resistance (or both) exercise training programmes, and the primary dependent variables had been physiological markers of physical fitness and disease state. Results have been uniformly positive. Specifically, cardiovascular endurance or aerobic exercise has been consistently reported to provide medium to large increases in fitness as indicated by increases in aerobic capacity (maximum oxygen consumption [$\dot{V}O_{2max}$]) and lactate threshold.[84-89] Likewise, resistance exercise in the form of weightlifting, particularly when combined with testosterone therapy, has shown similar beneficial physical effects within this population.[90-94] HIV-infected men and women have consistently shown increases in muscular strength and endurance and/or lean body mass, as well as increases in physical function and decreases in serum triglycerides[95-100] with resistance training. Importantly, several recent studies have attempted to use aerobic and/or resistance training to combat the morphological effects of lipodystrophy.[101-104] However, there has yet to be an effective group of studies that have shown significant changes in HAART-induced body fat alterations with exercise training.

Nonetheless, it is clear that HIV-infected persons respond to training in much the same manner as their healthy counterparts. They are capable of performing intense exercise training and they realise similar improvements in physical fitness as a result of this training. Although exercise training has been linked to reduced disease activity,[105] to date, no group of

studies have shown significant positive changes in disease state (i.e. CD4 cell count, viral load) with any form of exercise training. However, we are unaware of any reports that cite any significant negative effects of exercise on the immune and disease markers in this population. Thus, exercise appears to be neutral in its effect on immune and disease markers for the HIV-infected population, while providing a clear benefit with regard to their fitness level.

Few studies have examined the impact of exercise on symptoms of HIV/AIDS or adverse effects of HAART. We are aware of only ten studies that have utilised self-reports of the most common effects: fatigue, pain, nausea, anxiety and/or depression in conjunction with exercise. A summary of these studies is presented in table I.

Survey data indicate that exercise is one of the most frequently reported self-care treatments for fatigue utilised by HIV/AIDS patients.[16] However, only two studies have been conducted that directly tested the impact of exercise on fatigue. In the first, 33 HIV-infected males completed either moderate-intensity aerobic exercise (in the form of cycling) or weightlifting.[109] Results indicated significant reductions in fatigue compared with those participants who were assigned to a control that included stretching and flexibility sessions. This work was replicated by Smith, et al.,[89] who showed that a 12-week aerobic exercise programme safely decreased fatigue in HIV-infected individuals as indicated by increased time to exhaustion on the treadmill. There is currently no study that has investigated the ability of exercise to provide nausea relief or HIV-related pain management. However, Nicholas et al.[111] cited exercise as self-care strategy to reduce peripheral neuropathy pain in HIV/AIDS individuals. As mentioned previously, exercise has successfully reduced nausea and pain in cancer and fibromyalgia patients, respectively, and thus represents a potential area of promise for this population.

A greater number of studies have examined anxiety and depression in conjunction with exercise in the HIV/AIDS population. The first of these studies investigated the impact of exercise training on the notification of HIV status.[112] Although all participants responded with an increase in depression when they were informed that they were HIV infected, the magnitude of this change was significantly lessened in those who had completed 5 weeks of interval training prior to notification. This is the only study that has purposely examined the effect of exercise on individuals unaware of their infection. Perhaps due to concerns with the ethical nature of the design, all other studies have focused on HIV-infected individuals who were aware of their infection.

The majority of studies that have examined the impact of exercise training on indicators of psychological health have found significant improvements in depressed mood, anxiety or other indicators of psychological state. For example, a newly published study demonstrated significant improvements in measures of depressive symptoms and depressed mood after 12 weeks (three 1-hour sessions per week) of aerobic activity at 60–80% $\dot{V}O_{2max}$.[106] Significant improvements in depressed mood were demonstrated in the Center for Epidemiological Studies-Depression Scale and Profile of Mood States, with a similar but non-significant improvement for depression as measured by the Beck Depression Inventory (BDI). Likewise, in an earlier study of 23 HIV-infected males, depressed mood was reduced following 12 weeks of a mixed aerobic/resistance/flexibility training protocol.[108] The reduction in depressed mood in this study did not differ from controls, suggesting that the changes could have been caused by other factors related to the study, or that this benefit does not depend upon changes in aerobic exercise. Other studies have supported the changes in depression compared with a no-exercise control group. For example, Lox et al.[109] found that both 12 weeks of aerobic and 12 weeks of resistance exercise were sufficient to increase positive well-being and reduce perceived distress relative to controls. Likewise, another study showed significant increases in various markers of psychological well-being after 12 weeks of exercise training.[93] This study compared the effects of exercise training (aerobic and/or resistance) combined

Table I. Summary of studies that have examined the psychological response to exercise

Study	n	Sample description	Mean age (y)	Exercise history	Exercise mode	Exercise intensity	Exercise duration (min)	Exercise frequency	Control condition	Dependent variable(s)	Outcome
Neidig et al.[106]	60	HIV+ 13% F	36.0	Mixed history	Various aerobic activities	60–80% $\dot{V}O_{2max}$	60	12 wks 3× per wk	NI	Depressive symptoms, depressed mood	Improved relative to control
Agin et al.[99]	30	HIV+ F	41.0	Sedentary	Progressive resistance exercise	Mod/vig	30	16 wks 2× per wk	NI lead-in	QOL	Improved in various subscales relative to lead-in
		HIV+ F	43.4	Sedentary	Progressive resistance exercise & protein supplement	Mod/vig	30	16 wks 2× per wk	NI lead-in	QOL	Improved in various subscales relative to lead-in
Terry et al.[107]	31	HIV+ 45% F	31.0	Sedentary	Treadmill	55–60% $\dot{V}O_{2max}$	60	12 wks 3× per wk	NI lead-in	Depression	No change
		HIV+ 45% F	30.0	Sedentary	Treadmill	75–85% $\dot{V}O_{2max}$	60	12 wks 3× per wk	NI lead-in	Depression	No change
Stringer et al.[87]	26	HIV+ 11% F	36.0	Mixed history	Cycle ergometer	≈60% $\dot{V}O_{2max}$	60	6 wks 3× per wk	NI	QOL	Improved relative to control
		HIV+ 11% F	36.0	Mixed history	Cycle ergometer	≈75% $\dot{V}O_{2max}$	30–40	6 wks 3× per wk	NI	QOL	Improved relative to control
Wagner et al.[93]	54	HIV+ M	40.0	Mixed history	Various self-report			12 wks NA	None, cross-sectional	QOL, depression, anxiety	Exercise interacted with testosterone treatment to improve all variables
Lox et al.[108]	23	HIV+ M	36.5	Sedentary	Cycle ergometer	50–80% HRR	24	12 wks 3× per wk	Stretch & flexibility	Positive well-being, distress, fatigue	Improved relative to control
		HIV+ M	36.5	Sedentary	Resistance	60% 1RM	24	12 wks 3× per wk	Stretch & flexibility	Positive well-being, distress, fatigue	Improved relative to control
Lox et al.[109]	33	HIV+ M	36.5	Sedentary	Cycle ergometer	50–80% HRR	24	12 wks 3× per wk	Stretch & flexibility	Life satisfaction, mood state	Improved relative to control
		HIV+ M	36.5	Sedentary	Resistance	60% 1RM	24	12 wks 3× per wk	Stretch & flexibility	Life satisfaction, mood state	Improved relative to control

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Table I. Contd

Study	n	Sample description	Mean age (y)	Exercise history	Exercise mode	Exercise intensity	Exercise duration (min)	Exercise frequency	Control condition	Dependent variable(s)	Outcome
MacArthur et al.[85]	24	HIV+ 15 M, 1 F	35.4	Sedentary	Various aerobic interval training	50–60% $\dot{V}O_{2max}$	40	24 wks 2× per wk	None	Health-related QOL	No change
		HIV+ 15 M, 1 F	35.4	Sedentary	Various aerobic interval training	75–85% $\dot{V}O_{2max}$	24	24 wks 2× per wk	None	Health-related QOL	No change
Rigsby et al.[84]	37	HIV+ M	34.9	Sedentary	Cycle ergometer, resistance, stretching	60–80% HRR mod/vig	25, 20–25, 10–15	12 wks 3× per wk	Fitness & relaxation counselling	Depression	Improved pre-post; no difference from controls
Schlenzig et al.[110]	28	HIV+ M	NA	NA	Sedentary cardiovascular-based sport	Mod/vig	60	8 wks 2× per wk	NI	Depression, anxiety	Improved

F = females; **HRR** = heart rate reserve; **M** = males; **mod** = moderate; **NA** = data not available; **NI** = no intervention; **QOL** = quality of life; **vig** = vigorous; **1RM** = 1 repetition maximum; $\dot{V}O_{2max}$ = maximum oxygen consumption.

with testosterone therapy to testosterone therapy alone. Both groups decreased in depression but the exercise group also reported reductions in anxiety and increased in quality-of-life scores that were not found for the controls. This finding is consistent with the earliest reports of the beneficial psychological effects of exercise in this population.[110]

There is only one study that did not find any change in depression with exercise.[107] There were no significant changes in depression scores on the Montgomery-Asberg Depression Rating Scale (MADRS) in 21 sedentary HIV-infected individuals following 12 weeks of moderate- or high-intensity aerobic exercise. Considering that this study utilised a similar exercise programme as other studies (60 minutes, three times per week at target intensity), it is likely that the lack of change in depression scores was not due to a failure of exercise to impact depressed moods, but rather depression. The MADRS is a clinical measure of depression, and similar to the above study, which utilised the BDI (another clinical measure), there does not seem to be a change in depression with exercise. However, the majority of studies have shown beneficial effects on depressed mood. Thus, in summary, it appears that exercise training is sufficient to reduce depressed mood and anxiety in HIV-infected persons.

The improvements in depressed mood and anxiety are likely contributors to the demonstrated improvements in self-reported quality of life. For example, Stringer et al.[87] randomised participants into control, moderate- or high-intensity exercise groups. The control group reported significantly lower quality-of-life scores than either of the exercise groups. Likewise, Agin et al.[99] used 30 women randomised into three groups: protein supplementation (PRO), progressive resistance exercise (PRE) and a combination of both (PRO-PRE), and asked them to report on eight subscales of quality of life, including vitality, general health perceptions, mental health and role activity limitations due to emotional problems. Participants in PRE significantly increased in quality of life, while those in the PRO significantly decreased in quality of life.

Although it appears that both aerobic and resistance modes of exercise can benefit HIV/AIDS patients, there are a number of limitations to this work. Most of the research focusing on issues of anxiety or depressed moods was done prior to the advent of HAART.[84,85,93,109,110,112] High mortality, opportunistic infections and wasting syndrome were much more common than today. Because current treatment allows HIV-infected individuals a longer, healthier life, it is likely that baseline levels of anxiety and depression, although high, are quite different than those seen in early samples of HIV-infected persons. Because the psychological benefits of exercise are impacted by the baseline state of the participants,[113] it is important to replicate these results in conjunction with HAART. In addition, the majority of the above studies have had small sample sizes, a problem that is confounded by a high degree of attrition. For example, one study began with 24 participants, to see only six complete the full intervention.[84] Although the majority of these studies have utilised sedentary participants, the high attrition rates limit the ability to generalise these results across the population of HIV/AIDS patients. Moreover, only one study has followed a significant number of HIV-infected females in an exercise training programme.[98] Finally, single bouts of moderate- to high-intensity aerobic and or resistance exercise have been shown to decrease pain, anxiety, depressed mood, and increase positive mood state and energy in other populations.[55,56,63,79,81,82] Despite this, all of the studies with HIV-infected persons that have addressed these issues have utilised long-term exercise. Again, given that HAART and HIV-infection result in effects that reduce the likelihood of lasting exercise participation, it is particularly important that research tests the efficacy of single bouts of exercise to provide a benefit.

It should also be noted that two of the most recent studies report global psychological changes (e.g. quality of life) rather than an assessment of an isolated psychological state (e.g. anxiety, depression, mood).[87,98] While quality of life is an important indicator of health, it does not capture the range and depth of the psychological and physical response to exercise and, as a result, provides a minimal test of the effectiveness of exercise as a treatment for the adverse effects of HIV/AIDS and HAART. Finally, although a small number of studies have assessed fatigue, depression and anxiety, no studies have examined the impact of exercise on pain or nausea and vomiting. The failure to fully assess the range of symptoms that afflict HIV/AIDS patients prevents a recommendation for exercise as a specific intervention for symptom and adverse effect management.

4. Conclusion and Recommendations

There is a limited research base that has examined the efficacy of exercise to treat the most common symptoms of HIV/AIDS and the adverse effects of HAART. Results of this research suggest that exercise training of 8–12 weeks will result in reduced fatigue, anxiety and depressed mood, along with an improved quality of life. However, given the dated nature of much of this research, it is not clear that these effects will occur with HIV/AIDS patients who have had access to HAART. Despite this, the benefits of exercise in other chronic disease populations suggest that exercise is a useful strategy to manage these symptoms. In addition, there is no evidence that HIV-infected persons respond negatively to exercise. As a result, clinicians are currently advised to construct a general exercise programme to fit the individual; one that takes into account the stage of disease, symptoms and adverse effects experienced, functional ability[114] and frequency, intensity, duration and mode of exercise. Given the limited results for single bouts of exercise, patients should be counselled that they may need to experience some short-term discomfort (i.e. dyspnoea, pain) to achieve the long-term benefits of exercise. Specific recommendations would include an aerobic exercise programme of 3–5 sessions/week, 20–60 minutes/session, at 50–85% HR_{max} or 45–85% $\dot{V}O_{2max}$. Resistance exercise should focus on large muscle groups, at a moderate intensity of 8–12 repetitions per exercise, increasing these parameters with the patient's progress.[114]

Although both long- and short-term exercise has been shown to provide relief to a host of maladies in both healthy and chronic disease populations, these effects have not received similar attention with HIV/AIDS patients. The little research that does exist, has small sample sizes, which has precluded an examination of possible moderators to these effects (e.g. sex and ethnic status, disease progression). As a result, no research has examined possible mediators for these benefits. Furthermore, the high attrition rates suggest that these results may have been garnered from a particular subset of the HIV/AIDS population, whose results may not generalise to a wide range of HIV infected persons. Previous exercise history is associated with adherence to training regimens, even in persons who are presently sedentary.[115] Although speculative, it may be that those participants with an extensive history of exercise are less likely to withdraw from the intervention. Likewise, it may be that those who are experiencing the greatest number of symptoms or adverse effects are less likely to adhere to an exercise programme, or that the severity of symptoms experienced in the pre-HAART era prevented participation in these early studies. As a result, study designs should allow for the attrition of 50–70% of participants and allow for an in-depth baseline assessment of any factors that would be expected to impact attrition, e.g. disease state, symptomology, exercise history and self-efficacy.

In summary, HAART has transformed HIV infection into a chronic illness. Given the high rates of survivorship in conjunction with HAART, future research should be designed to examine the independent and relative impact of exercise training on the full range of symptoms and adverse effects that affect HIV/AIDS patients who are undergoing HAART, with a particular interest in examining possible limits to this effect. It is only through an extended examination of this field that more specific exercise programmes can be developed and tailored to the needs of this population.

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