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Comprehensive Examination

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**Topic: Benefits of Exercise for Individual with HIV/AIDS**

Considering the disease pathophysiology of HIV/AIDS, discuss original evidence from the literature indicating the benefits of exercise for individuals with HIV/AIDS. What are the limitations of the current literature and directions for future research?

Since the introduction of highly active antiretroviral therapy (HAART) in 1996, the lifespans of people with human immunodeficiency virus (HIV) has been extended by 14-26 years (Lugassy, 2010). However, the combination of HIV and its treatment on the metabolism of the individual often marks these additional years with a variety of health complications (Rusch et al., 2004). One method of addressing these adverse conditions is through the application of exercise programs. Numerous researchers have investigated the effects of aerobic exercise (AE) interventions and resistance exercise (RE) interventions on people suffering from HIV. I will discuss these studies separately, beginning with resistance training interventions.

**Resistance exercise interventions**

The following studies are randomized controlled trials that investigate the application of RE programs on people with HIV, lasting at least 6 weeks:

Authors Duration Control group Sex Notes

Spence et al., 1990 6 weeks Yes Male

Rigsby et al., 1992 12 weeks Yes Male RE combined with AE

Lox et al., 1995 12 weeks Yes Male Included both RE and AE

Grinspoon et al., 2000 12 weeks Yes Male RE combined with AE

Bhasin et al., 2000 16 weeks Yes Male

Agin et al., 2001 14 weeks No Female Included whey protein group

All of the above studies had a control group except Agin et al. (2001). However, because this study investigated women and all the other major randomized controlled trials only included men, I’ve included this study in my discussion of the effects of RE on people with HIV. The most common duration among RE interventions is 12 weeks, but Spence et al. (1990) only lasted 6 weeks, while Agin et al. (2001) lasted 14 weeks, and Bhasin et al. (2000) lasted 16 weeks. Although the form of exercise in Rigsby et al. (1992) and Grinspoon et al. (2000) are combine both AE and RE components, I’ve chosen to discuss the findings of each study in the RE section. Lox et al. (1995) includes a non-exercising control group, an RE group, and an AE group. For this reason, I will be discussing Lox et al. (1995) in both the RE and AE sections. The major findings regarding the benefits of exercise for people living with HIV are outlined below:

**Bodyweight**

Grinspoon et al. (2000) found subjects in the RE group to gain an average of 1.7 kg while subjects in the non-exercise control group lost an average of 0.6 kg. While this difference was trending, it was not enough to constitute significance.

In Spence et al. (1990) however, subjects in the RE group gained the same amount of weight (1.7 kg) but lost an average of 1.9 kg, which was enough to achieve significance.

The largest difference in bodyweight was found in Lox et al. (1995), in which subjects in the RE group gained 2.1 kg while subjects in the non-exercising control group lost 4.5 kg. This difference was significant.

The largest amount of weight gain achieved was in Bhasin et al. (2000), who found subjects in the RE group to gain 2.2 kg. Although subjects in the non-exercising control group only lost 0.5 kg, this difference was significant.

Agin et al. (2001) did not have a control group against which the comparison could be made and Rigsby et al. (1992) did not report these data.

In summary, among people with HIV, RE interventions appear to have an effect of increasing bodyweight. The positive nature of this is reflected in the body composition findings.

**Body composition**

Grinspoon et al. (2000) found the greatest improvement in body composition, with subjects in the RE group to gain an average of 2.3 kg of lean body mass while losing an average of 1.3 kg of fat mass. This was significant. Subjects in the control group did not significantly alter body composition. However, it should be noted that these findings due contrast with the findings of total weight change. If subjects in the RE group gained 2.3 kg of lean body mass and lost 1.3 kg of fat mass, that amounts to a 1.0 kg body weight change. In their report on body weight change, they reported a 1.7 kg increase.

More modest findings in body composition were found in Bhasin et al. (2000), in which subjects in the RE did not significantly change in fat mass, but gained 2.0 kg in lean body mass. This difference was significant. No significant changes were found in subjects in the non-exercising control group.

In Agin et al. (2001), subjects in the RE group only gained 0.7 kg of lean body mass, but lost 1.7 kg of fat mass. This difference was significant. There was no control group against which these data could be compared.

In summary, it seems RE promotes positive changes in body composition. Men undergoing RE programs might be more inclined toward gains in lean body mass whereas women might be more inclined toward losses of fat mass. This is just an observational extraction from the findings and cannot be confirmed without a study that includes both men and women investigating this question.

**Strength**

All of the above studies with the exception of Grinspoon et al. (2000) found significant improvements to strength. In Grinspoon et al. (2000), strength improvements were not found in any of the 7 measures used to assess it. There were 2 explanations proposed for this. First, it could be due to the isometric strength assessments. The RE program was strictly isotonic training, so there might not have been a translation of isotonic strength improvements to an isotonic testing protocol. Second, the inclusion of an AE component may have limited the amount of strength gain possible. AE can increase AMP-kinase which then inhibits mammalian target of rapamyacin, a cell signaling cascade responsible for protein synthesis (Berg, 2002). However, Rigsby et al. (1992) also included an AE component in their protocol and found significant improvements (29-36%) in all 5 of their strength measures. Therefore, the more likely explanation is the testing measures Grinspoon et al. (2000) used to assess strength.

The most robust findings in strength occurred in Spence et al. (1990), where subjects in the RE group significantly improved in 22 out of 24 strength measures assessed. Conversely, subjects in the non-exercising control group found significant reductions in strength in 13 of these measures. Although these findings occurred in only 6 weeks, it should be noted that this study took place before the advent of HAART and many of the subjects had more severe symptoms of HIV (e.g., muscle wasting), than those found in Grinspoon et al. (2000).

**Other cardiovascular disease (CVD) risk factors (lipids-lipoproteins and blood pressure)**

In a “Current Perspectives” paper appearing in *Circulation*, Barbaros (2000) brought attention to the high incidence of peripheral and coronary artery disease among people with HIV. Although this was published nearly 13 years ago, it helped initiate further research into the causes of these correlations. What Barbaros suggested was that it was the result from metabolic disorders brought about by the effect of HAART (especially antiretroviral medications like zidovudine, a nucleoside reverse transcriptase inhibitor) affecting the mitochondria.

These suggestions were thereafter corroborated when the mechanisms of pathogenesis began to be elucidated in more detail. These subsequent studies lead to the publication of more detailed summaries. Scruggs (2008) and Maagaard (2009) describe the origin of the metabolic disorders described by Barbaros (beginning with mitochondrial DNA depletion and dysfunction of the electron transport chain).

The medications that Barbaros referenced inhibit DNA polymerase gamma (enzyme responsible for the replication of mitochondria) in one of two ways. In vitro, this occurs by competitive inhibition via competing with the natural substrates (endogenous nucleotides) on the nucleotide bindings sites on DNA polymerase gamma. In vivo, this may not occur as readily and another mechanism has been proposed (competitive inhibition of thymidine kinases – particularly TK2 – which results in depletion of the thymidine triphosphate pool, which is necessary for mitochondrial replication). Whatever the mechanism, HAART impairs mitochondrial replication, and thus total content is reduced.

Furthermore, the electron transport chain is compromised by HAART through its inhibition of enzymes at complex 1 and 2, reduction in protein subunits at complex 4 (cytochrome c oxidase), impairment of ADP-ATP translocase (antiporter enabling ADP and ATP to cross the inner mitochondrial membrane) and inhibition of adenylate kinase (enzyme involved in the manufacturing of ATP).

As Scruggs (2008) and Maagaard (2009) illustrate, the combination of reduced mitochondrial content and impaired mitochondrial functioning results in an overreliance on glycolytic metabolism, a metabolic environment that encourages acidosis, and an excess of free radicals.

Heidigan (2005) provides a summary in which these effects translate to CVD risk factors. The elevated lactate levels impair insulin signaling, leading to diabetes (and diabetic-like states) and the oxidative damage caused by the excess of free radicals reduces the amount of adiponectin in circulation. Adiponectin, released by the adipocytes, is a hormone involved in glucose clearance. Low serum levels of adiponectin is an independent risk factor for the metabolic syndrome (Renaldi et al., 2009).

Lastly, Klatt (2012) describes a condition commonly experienced by people with HIV known as futile cycling. In futile cycling, fatty acids undergo lipolysis and are mobilized to the blood, but instead of then being oxidized, they’re re-esterified and restored as triglycerides. This leads to a state in which, even in elevated metabolic conditions, lipid metabolism is severely impaired.

Given all of these conditions, two issues become apparent. 1) People with HIV frequently have poor CVD risk profiles, and 2) due to the altered metabolic states at the foundation of these profiles, exercise alone may not be enough to reverse or correct them.

One study that addressed the CVD risk profiles of people with HIV was Driscoll et al. (2004). This was a 3-month study in which people with HIV were assigned to either 1) Metformin plus exercise, or 2) Metformin alone. The exercise included both aerobic and resistance training.

In their results, no improvements were found in the exercise group (above and beyond results found in the Metformin alone group) in lipid-lipoprotein profiles. However, Driscoll et al. did find statistically significant improvements in both systolic and diastolic blood pressure, serum insulin levels, and wasit-to-hip ratio (as a surrogate measure for CVD risk).

They concluded that, although some components of the CVD risk profile may not be improved through the application of exercise (possibly due to altered metabolic states at the foundation of the impairment), some components are improved, blood pressure among them.

**Cardiovascular performance**

Aside from the CVD risk profile, minor cardiovascular changes have been shown to manifest in people with HIV undergoing RE programs.

Among the exercisers in Rigsby et al. (1992), improvements were found in time until exhaustion and heart rate at maximal workload. These improvements were found in a protocol that included an aerobic component however. It’s likely that the aerobic component accounted for all of these improvements.

When comparing RE-only to AE-only protocols, Lox et al. (1995) found significant improvements to VO2 max in their AE group while finding no differences between the RE group and the non-exercise control group.

However, in Rigsby et al. (1992), changes to the heart rate max were larger than those found in Lox et al. (1995). This discrepancy may suggest that a combination of AE and RE may elicit more favorable results than AE or RE alone, but this is merely speculation. No studies that I have found have addressed this question.

**Immunological profile**

Rigsby et al. (1992) and Grinspoon et al. (2000) found no change in immunological indices (CD4+ count or viral load). Lox et al. (1995) found a non sig increase in CD4+ count among subjects in the RE group and a non-significant decrease in CD4+ count among subjects in the non-exercising control group. Overall, it seems unlikely that RE alters the immunological profile.

**Safety of RE**

Spence et al. (1990) and Lox et al. (1995) did not report on adverse events. Grinspoon et al. (2000) and Bhasin et al. (2000) did report on the occurrence of adverse events, but had no adverse events to report. Rigsby et al. (1992) and Agin et al. (2001) reported adverse events.

Agin et al. (2001) reported one death of a subject who was in the RE plus whey protein group. This was not reported to be connected with exercise.

Rigsby et al. (1992) reported 12 adverse events, 7 of which occurred in the non-exercise control group, and 5 occurred in the exercise group. Of the 12 adverse events, 3 of were deaths. Of these 3, 1 occurred during the course of the study (non-exercise group) and 2 occurred following completion of the study (1 in each group). The remaining 9 adverse events were subject dropouts reported to be due to health. Of these, 4 were in the exercise group and 5 were in the non-exercise group. It should be noted that this study took place before the introduction of HAART and many of these adverse health conditions may have been avoided had modern pharmacological treatment been available.

**Conclusion regarding RE**

It appears that people with HIV may benefit from RE interventions in several ways. When done appropriately, they are a safe way to improve strength, body composition, and indices of cardiovascular health (e.g., blood pressure and heart rate max) when combined with AE, but are not likely to alter one’s immunological profile.

**Aerobic exercise interventions**

The following studies are randomized, controlled trials in which aerobic exercise interventions lasting at least 6 weeks (with frequencies, intensities, and durations that meet the criteria established by ACSM’s Guidelines for Exercise Testing and Prescription, 2009) were applied to people living with HIV.

Authors Duration Control group Sex Notes

Lox et al., 1995 12 weeks Yes Male Included both AE and RE

Stringer et al., 1998 6 weeks Yes Both AE had 2 intensities

Perna et al., 1999 12 weeks Yes Both

Terry et al., 1999 12 weeks No Both Only included 2 intensities

Smith et al., 2001 12 weeks Yes Both

Baigis et al., 2002 15 weeks Yes Both

Dolan et al., 2006 16 weeks Yes Female AE with RE component

Multimura et al., 2008 24 weeks Yes Both

Although Rigsby et al. (1992) and Grinspoon et al. (2000) had aerobic interventions in their studies, I did not include either due to my discussion of their findings in the RE section. I did include Lox et al. (1995) in the AE section due to the inclusion of an AE-only exercise group. Stringer et al. (1998) and Terry et al. (1999) had protocols that involved 2 different intensities of AE (high and low). Stringer et al. compared these different intensities to a non-exercising control group. Terry et al. (1999) had no control group. All other studies compared their AE groups to non-exercising control groups. Similar to the RE studies, 12 weeks is the most common study duration. The exceptions were Stringer et al. (1998) whose study lasted 6 weeks, Baigis et al. (2002) whose study lasted 15 weeks, Dolan et al. (2006) whose study lasted 16, and Multimura et al. (2008) whose study lasted 24 weeks. Although both sexes were represented in 6 out of 8 studies, men were predominantly represented in these subject populations. I will describe the outcomes of the studies below.

**Bodyweight**

Smith et al. (2001) found a non-significant decrease in bodyweight among subjects in their AE group. Of the other studies that reported on bodyweight (e.g., Terry et al., 1999), there were no changes to bodyweight. Body composition however did elicit findings.

**Body composition**

Lox et al. (1995) found significant improvements to body composition in both RE and AE groups compared to the non-exercising control group. Smith et al. (2001) found statistically significant improvements in body mass index (BMI), waist circumference (WC), waist-to-hip ratio, and skin folds measurements. Multimura et al. (2008) found significant improvements in BMI, WC, waist-to-hip ratio, and body fat percent among subjects in their AE group compared to no changes in their non-exercising control group. Terry et al. (1999) found no changes in either of their AE interventions (high or low intensity).

**Heart rate max**

Perna et al. (1999) was the only author to report a change in heart rate max (reduction in heart rate at maximum workload), finding non-significant improvements in the AE group.

**Work rate max**

Stringer et al. (1998) found a significant improvement in work rate max. Moreover, they found a dose response, in which their higher intensity AE group achieved greater improvements in work rate max than did their lower intensity AE group. This was marked by similar (statistically significant) improvements to lactic acid threshold.

**Time until exhaustion**

Terry et al. (1999) and Smith et al. (2001) reported statistically significant improvements in time until exhaustion in subjects in the AE groups. Additionally, Terry et al. (1999) found a dose response in which subjects in their higher intensity AE group improved greater than subjects in their lower intensity AE group. There was no non-exercise control group against which comparisons could be made.

**VO2 max**

All authors except Baigis et al. (2002) reported statistically significant improvements to VO2 max. However, Smith et al. (2001) also reported statistically significant improvements to VO2 max among their non-exercising control subjects, which makes their testing protocols somewhat suspect (although possible that people with HIV could have improved by chance given changing life circumstances). Stringer et al. (1998) found the change in VO2 max to occur as a dose response to exercise intensity, with the subjects in the higher intensity exercise group exhibiting larger increases to VO2 max.

**Pulmonary measures**

Perna et al. (1999) found statistically significant improvements in minute ventilation and ventilator threshold, which may help contribute to their improvements to VO2 max.

**Strength**

Lox et al. (1995) and Dolan et al. (2006) both reported improvements to strength, but these were correlated with the RE interventions prescribed. Perna et al. (1999) was the only study to report increases in strength related to the AE intervention, in which subjects in the AE group who were compliant with the intervention increased leg power by 25%.

**Immunological profile**

No studies reported an improvement to the immunological profile except Perna et al. (1999), who found subjects in the AE group who were compliant with exercise to increase CD4+ count by 13%, subjects in the non-exercise control group to decrease CD4+ count by 10%, and subjects in the AE group who were not compliant with the exercise protocol to decrease CD4+ count by 18%. These findings may be somewhat spurious based on sample sizes of 11, 10, and 7 respectively.

**Safety**

Perna et al. (1999) found one hospitalization of a subject in the exercise group. Details were not provided if this was related to the exercise intervention. Dolan et al. (2006) reported two adverse events. Chest pain was reported in one non-exercising control subject and exacerbation of asthma was reported in one subject in the exercise group. Neither was reported to be related to exercise.

**Conclusions**

Aerobic exercise, when conducted in accordance with the recommendations provided by ACSM’s Guidelines for Exercise Testing and Prescription (2009) appears to be a safe strategy to improve body composition (assessed in a variety of ways, including BMI, CM, waist-to-hip ratio, skin fold measurements, and body fat percent), cardiovascular performance (assessed by VO2 max, pulmonary measures, work rate max, time to exhaustion, and lactic acid threshold), lower systolic and diastolic blood pressure when combined with RE, and possibly improve leg power and CD4+ count.

**Overall strengths and weaknesses of the literature**

There have been numerous studies characterizing the positive changes induced by both AE and RE exercise protocols among men and women with HIV. I’ve illustrated many of these above.

What needs further investigation is the difference between men and women when administered AE and RE protocols. Even in studies in which both sexes are included, there’s typically an overwhelming majority (>80%) of men (see the studies listed in the AE table on page 6). It would be helpful if similar interventions could be conducted on a more balanced demographic. Moreover, the sex-dependent differences in body composition in responses to RE would be an interesting area to explore. To date, I’m only able to make assertions based on the women-only findings in Agin et al. (2001) against the men-only findings in studies such as Spence et al. (1992) and Bhasin et al. (2000).

Furthermore, differences between AE-alone and RE-alone against RE and AE combined should be explored. Most studies include either RE and AE combined against a non-exercising control group, or RE alone and AE alone against a non-exercising control group (see Lox et al., 1995).

Lastly, what needs to be researched much more thoroughly is how the FITT principle affects CVD risk profiles and immunological indices among men and women with HIV. Knowing that BP is more susceptible to change than lipids-lipoproteins or markers of immune functioning is not enough to design an appropriate exercise program for someone with HIV who is looking to reduce the chance of peripheral and coronary artery disease and/or further immune system compromise.

**Topic: American College of Sports Medicine Exercise Testing and Prescription Guidelines**

1a. What are the American College of Sports Medicine exercise prescription guidelines for healthy adults?

1b. What are the American College of Sports Medicine exercise prescription guidelines for individuals with HIV/AIDS?

1c. What are the American College of Sports Medicine special considerations in exercise testing and prescription guidelines for individuals with HIV/AIDS?

1d. How do the American College of Sports Medicine exercise testing prescription guidelines for healthy adults differ from those with HIV/AIDS?

**1a.** General exercise recommendations for healthy adults are described in Table 7.1 in ACSM’s Guidelines for Exercise Testing and Prescription (GETP8, 2009), as follows:

At least 5 days a week, moderate intensity aerobic activity (corresponding to 40-60% VO2R), weight bearing activity, and flexibility exercise should be done.

At least 3 days a week, vigorous intensity aerobic exercise (corresponding to greater than or equal to 60% VO2R), weight-bearing exercise, and flexibility exercise should be done.

Between 3-5 days a week, one should engage in a combination of moderate and vigorous intensity activities, including aerobic activity, weight bearing exercise, and flexibility exercise.

Between 2-3 days a week, one should engage in muscular strength and endurance activities, including resistance exercise, calisthenics, balance, and agility exercise.

Regarding frequency and intensity, on page 155, GETP8 notes that there is a “positive continuum of health/fitness benefits with increasing intensity.” GETP8 also notes that there is a similarly positive continuum with frequencies greater than 3 days a week, but a plateau is typically reached above 5 days a week. For these reasons, ACSM suggests moderate intensity aerobic exercise should be conducted at least 5 days a week or vigorous intensity at least 3 days a week, or some combination of the two 3-5 days a week.

Regarding time, if moderate intensity is to be conducted, it should be performed for at least 30 minutes a day for at least 5 days a week, totaling at least 150 minutes. If vigorous intensity is to be chosen, it should be done for at least 20-25 minutes at least 3 days a week, totaling at least 75 minutes during the week. If a combination is to be chosen, this should be 3-5 days a week for at least 20-30 minutes per session.

The specific frequency, intensity, time, and type (FITT) for apparently healthy adults should be modified to fit the habitual activity level of the individual however. Table 7.4 (page 166) in GETP8 describes 5 different levels of baseline activity (sedentary, minimal physical activity, sporadic physical activity, habitual physical activity, and high amounts of habitual activity). Each of these is characterized with a classification of physical fitness (poor, poor-fair, fair-average, average-good, good-excellent). The FITT principle is then applied differently to each different class (although type is not characterized here).

For example, someone who gets sporadic physical activity, who is classified as having fair to average physical fitness, is recommended to engage in the following:

Frequency: expend 1500-2000 kcal 3-5 days per week.

Intensity: 55-70% HRR/VO2R, or 74-84% HRmax, or “moderate to hard” perception of effort.

Time: 30-90 minutes per day with a weekly duration of 200-300 minutes, or total daily steps during exercise being between 3,000 and 4,000.

**1b.** Among people with HIV/AIDS, the exercise prescription changes. GETP8 notes that the population is highly heterogeneous and thus modifications might need to be made on a case-by-case basis. However, a combination of aerobic and anaerobic exercise should be incorporated as several of the impairments and limitations to activity can be improved with such a program. The recommendations for people with HIV/AIDS are provided on page 247 of GETP8:

Frequency: aerobic exercise should be done 3-4 days a week while resistance exercise should be done 2-3 days a week.

Intensity: aerobic exercise should be conducted at an intensity of 40% to 60% VO2R or HRR. The reason it should not be more intense is due to the possibility of immune system suppression among higher intensities. For resistance exercise, weights should be chosen to correspond with repetition ranges of 8-10. In the special considerations, GETP8 notes that asymptomatic patients people with HIV who are asymptomatic may be able to participate in more vigorous-intensity exercise than their more symptomatic (or immune compromised) counterparts.

Time: aerobic and resistance exercise should be combined to total 30-60 minutes a day, spread throughout the day if necessary. Regarding resistance training, the exercises should involve 10-12 muscle groups, conducting 2-3 sets per exercise.

Type: this is highly dependent on the individual. Not only do the interests of the individual vary, but HIV expresses disabilities in a variety of ways. Working around such disabilities (e.g., arthritis) may be necessary. However, it’s recommended for all people with HIV/AIDS to avoid contact sports in which bleeding is a possibility.

**1c.** In terms of exercise testing, this should be postponed if there is an acute infection.

When cardiopulmonary exercise tests are being conducted, possible modes of transmission of infection should be well controlled. Infection has not been shown to occur through saliva, but infectious agents such as respiratory pathogens may be involved. To minimize risks, use disposable equipment, etc.

Blood pressure and electrocardiogram should be employed to monitor cardiovascular function due to the increased prevalence of cardiovascular impairments.

When establishing RE programs, either maximal muscle strength testing or using a four-repetition predicted max can help determine the subsequent RE regime.

In terms of exercise prescription, at present (i.e., in GETP8; this may change in GETP9), there are no established guidelines for people with HIV/AIDS regarding contraindications for exercise. The guidelines in chapters 2 and 3 of GETP8 are intended to be used as generally (though cautiously) applicable.

Being as a considerable proportion of people with HIV do not have sufficient resources to exercise with professional monitoring, home exercise is likely to be a common mode of meeting the ACSM recommendations. Among the special considerations listed in GETP8, supervision of exercise is suggested nonetheless due to the commonness of comorbidities.

Another consideration involves the heterogeneity of symptoms among people with HIV/AIDS. As I mentioned in 1b., people who are not exhibiting symptoms may be able to exercise with greater intensity than those who have more compromised immune profiles or more pronounced health impairments.

Day-to-day variations in health are also common among people with HIV/AIDS, such as general fatigue, dizziness, swollen joints, and nausea. Although general fatigue should be considered, it shouldn’t preclude participation. Symptoms such as fatigue, dizziness, swollen joints, and nausea should preclude participation.

Lastly, progress of health-related components of physical fitness and CVD risk factors should be monitored among people with HIV/AIDS. As noted by GETP8, this is critical for appropriate clinical management and ongoing participation in exercise.

**1d.** The differences between apparently healthy populations and people with HIV are expressed explicitly in frequency, intensity, and time. Suggestions are made regarding type.

Regarding frequency, for apparently healthy populations, moderate intensity exercise can be done at least 5 days a week, vigorous intensity exercise at least 3 days, or a combination of the two 3-5 days. For patients with HIV, aerobic exercise should be done 3-4 days a week while resistance exercise should be done 2-3 days a week.

Regarding intensity, among apparently healthy adults, the recommendation corresponding to moderate intensity is 40-60% VO2R while the recommendation corresponding to vigorous intensity is greater than or equal to 60% VO2R. The VO2R recommendation for people with HIV is set at moderate (40-60%) with the addition that more intense exercise may be prescribed in special cases depending on immunological and symptomatic circumstances.

Regarding time, among apparently healthy adults, if moderate intensity exercise is performed, it should be conducted for at least 30 minutes a day, totaling at least 150 minutes a week. If vigorous intensity is to be chosen, it should be done for at least 20-25 minutes a day totaling at least 75 minutes during the week. If a combination is to be chosen, this should last 20-30 minutes per session. Among people with HIV, the total amount of exercise recommended is 30-60 minutes a day, spread throughout the day if necessary.

Regarding type, while a variety of exercise modalities are encouraged for apparently healthy populations, the mode of exercise for people with HIV is highly dependent on the individual. The chosen type should reflect both interests and disabilities. However, it’s recommended for all people with HIV/AIDS to avoid contact sports in which bleeding is a possibility.

**Topic: Case Study**

This case study is of a 50 yr old African American woman who has HIV (treated with Reyataz, Norvir, and Truvoda qid, dosage unreported), is sedentary, smokes, and has a history of a substance abuse disorder (history of crack cocaine 5x per month and presently not using). She is 5’4”, 152 lb, with a triglyceride level of 148 mg/dL, total cholesterol of 190 mg/dL, LDL cholesterol of 83 mg/dL, HDL cholesterol of 76 mg/dL, and a blood pressure of 138/80 mmHg. She suffers from seasonal asthma, which is controlled by Ventolin (Albuterol) prn. In 1996, she was diagnosed with Type II diabetes mellitus (DM). She monitors her blood glucose thrice daily with a home blood glucose monitor, and treats her DM with a 15 cc 70/30 Novolog qid. She avoids stair climbing due to mild arthritis in her right knee, which is treated with Advil prn. In November 2011, she fell down a flight of slippery stairs while carrying a few bags to her daughter’s house. Following her fall, she sought treatment from her physician and received a cortisone shot in her right arthritic knee. She was recently referred to Connections Wellness Center in Hartford, CT, to take part in your exercise research study looking at the effects of contingency management (a behavioral change strategy) and physical activity among individuals with HIV who are substance abusers.

Your health/fitness assessment revealed:

RHR: 113 bpm

BP: 126/74 mmHg risk classification: \_\_\_\_\_\_\_\_\_\_Pre-hypertension\_\_\_\_\_\_\_\_\_

BMI: 26.4 kg/m2 risk classification: \_\_\_\_\_\_\_\_\_\_\_\_Overweight\_\_\_\_\_\_\_\_\_\_\_\_\_

Waist circumference: 84.0 cm risk classification: \_Low risk\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sit and Reach: 29.5 cm risk classification: \_\_\_\_\_Lower bracket of very good\_\_

Handgrip Strength: 35 kg (RH: dominant), 35 kg (LH: non-dominant)

risk classification:\_\_\_\_\_\_\_\_\_\_\_Above average (>64kg for combined L/R)\_\_\_\_

Sit-to-Stand Test (HuskyCT pdf): 3.66 s (Performed independently without assistance) risk classification: \_I don’t recall these values. Based on little more than speculation, average for 50 yr; above average for a 50 yr with HIV\_\_\_\_\_\_\_\_\_\_

YSET (HuskyCT pdf): 21.0 ml/kg/min risk classification: \_\_\_\_Very poor\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Please answer the questions below as completely as possible.

What cardiovascular risk factors does she have?

Does she have major signs suggestive of disease? If so, please list.

What risk category is she based on your findings?

Is a medical examination necessary prior to testing and exercise participation? Why?

Is physician clearance needed prior to enrollment into your research study? Why?

Summarize the health/fitness assessment results as they will serve as the basis for the

exercise prescription that you will design for her.

What are her “special conditions/considerations”?

What other healthcare professionals should you consult when designing her exercise prescription?

Formulate her FITT-VP exercise prescription including special considerations.

1. What cardiovascular risk factors does she have?

Age. Being a woman, she must be at least 55 years of age to count as a risk factor. The subject is 50 years old. Thus, age is not a positive risk factor.

**Family history (+1).**  Family history was not provided in the details of the case study. Unknowns such as this are described on pages 23-24 of GETP8 as follows: “Health/fitness and exercise professionals and clinicians are encouraged to adopt a conservative approach to CVD risk-factor identification for the purposes of risk stratification, especially when (a) risk-factor information is missing and/or (b) the criteria for identifying the presence or absence of a specific risk factor cannot be determined or is not available. If the presence or absence of a specific risk factor is not disclosed or is unavailable, the risk factor should be counted as a risk factor, except for prediabetes.” To be consistent with the suggestions of GETP8, family history is counted as a positive risk factor.

**Cigarette smoking (+1).**  For this to count as a positive risk factor, she must be a current smoker or have quit within the last 6 months. The case study indicates she’s a current smoker.

**Sedentary lifestyle (+1).**  For this to count as a positive risk factor, the individual must not meet the ACSM recommendations for participation in moderate physical activity (at least 30 minutes a day at least 5 days a week) for at least 3 months. In the case study, the subject is described as “is sedentary.”

Obesity. For obesity to count as a CVD risk factor, BMI must be greater than or equal to 30.0 or waist girth must exceed 88 cm (for women). Her BMI is 26.4 and WC is 84.0 cm. Thus obesity is not a risk factor.

Hypertension. For hypertension to be considered a CVD risk factor, the subject must have a stage 1 hypertension diagnosis, confirmed on at least 2 separate occasions or be controlling blood pressure with an antihypertensive medication. Criteria for a stage 1 hypertension diagnosis is systolic blood pressure greater than or equal to 140 mm Hg and/or diastolic greater than or equal to 90. The subject’s blood pressure is 126/74 mm Hg. There is no indication that she is taking medication to treat it.

Dyslipidemia. For dyslipidemia to count as a CVD risk factor, low-density lipoprotein (LDL) cholesterol must be greater than or equal to 130 mg per dL or high-density lipoprotein (HDL) cholesterol be lower than 40 mg per dL or be on lipid lowering medication. If total serum cholesterol is all that is available, a reading greater than or equal to 200 mg per dL suffices for a risk factor. The subject has a triglyceride level of 148 mg/dL (“normal” according to ATP III classification in Table 3.2 of GETP8), total cholesterol of 190 mg per dL (“borderline high”), LDL cholesterol of 83 mg per dL (“optimal”), and HDL cholesterol of 76 mg per dL (“high”). Lipids-lipoproteins thus do not constitute a positive CVD risk factor.

**Prediabetes (+1).** For this to count as a CVD risk factor, the subject must have a fasting plasma glucose of greater than or equal to 100 mg per dL, but less than 126 mg per dL. If this isn’t met, but the subject has impaired glucose tolerance, marked by a 2-hour value in the oral glucose tolerance test of greater than or equal to 140 mg per dL of glucose (though less than 200 mg per dL), then this counts as a CVD risk factor as well. Although I don’t have the subject’s glucose measurements, I do know that she has type II diabetes mellitus, treated with a 15 cc 70/30 Novolog qid. Although GETP8 does not explicitly state that this counts as a CVD risk factor (it does count as a sign/symptom of disease), I will be counting this in the list of CVD risk factors in addition to signs/symptoms of disease.

**Negative risk factor:** The subject’s HDL cholesterol is 76 mg per dL (“high” according to ATP III classification in table 3.2). If HDL cholesterol is above 60 mg per dL, then it counts as a negative risk factor and one point is removed from the gross sum.

**Summary of risk factors.** The subject has a gross sum of 4 positive CVD risk factors: an implied family history (not stated), cigarette smoking, sedentary lifestyle, and “pre” diabetes (i.e., a diagnosis of type II diabetes mellitus). However, she has one negative risk factor (HDL above 60 mg per dL). Thus, the net sum of risk factors is 3.

1. Does she have major signs suggestive of disease? If so, please list.

The subject does have signs suggestive of disease. First and foremost, she is HIV positive. Secondly, she has diagnoses of diabetes, asthma, and a history of substance use disorder. If all she had were a known metabolic disease (i.e., diabetes) or a known pulmonary disease (i.e., asthma), this would automatically place her in the high risk category. Likewise, HIV or substance use disorder on their own would stratify her into the high risk category. The summation of all four ensures that, yes, she is considered high risk.

1. What risk category is she based on your findings?

High.

1. Is a medical examination necessary prior to testing and exercise participation? Why?

Yes. A medical exam is necessary prior to exercise testing or participation. Furthermore, during exercise testing, MD supervision is recommended for either maximal or submaximal. During the pre-participation screening process, the tools should always be relevant to the individual (in this case, most notably, HIV). In general however, certain CVD risk factors can be aggravated by acute exercise, predisposing an individual to elevated risk.

1. Is physician clearance needed prior to enrollment into your research study? Why?

Depending on randomization, enrollment in the study involves consistent exercise. On page 19 of GETP8, it quotes the Surgeon Generals’ Report on Physical Activity and Health (1996) as follows: “[P]reviously inactive men over age 40 and women over age 50, and people at high risk for cardiovascular disease (CVD) should first consult a physician before embarking on a program of vigorously physical activity to which they are unaccustomed.” While the activity would not be “vigorously physical” (rather, moderate), the subject is a 50 year old woman who is unaccustomed to physical activity and is at a high risk of CVD (3 CVD risk factors and 4 known diseases).

1. Summarize the health/fitness assessment results as they will serve as the basis for the

exercise prescription that you will design for her.

Although the subject only has a net sum of 3 CVD risk factors (4 positive results with one negative risk factor), and this would stratify her as “moderate risk” (greater than or equal to 2 risk factors), she also has 4 diagnosed diseases which automatically stratify her to the high risk category. Being in the high risk category, her activity should be restricted until safety is established. Once safety is established, the HIV-specific recommendations provided on page 246 of GETP8 will function as the foundation of the exercise prescription, making changes only to accommodate special needs and day-to-day variations of symptoms (as noted in the special considerations).

1. What are her “special conditions/considerations”?

The subject has no absolute contraindications to exercise (as described on page 54 of GETP8), but the primary consideration is her HIV. This is considered a relative contraindication to exercise testing, as stated: “Chronic infectious disease (e.g., mononucleosis, hepatitis, AIDS).” HIV is the condition that puts her at the highest risk and her exercise testing and prescription will reflect this.

Secondarily, if her arthritis is exacerbated by exercise, this becomes a relative contraindication as well: “neuromuscular, musculoskeletal, orrheumatoid disorders that are exacerbated by exercise.” Among patients with HIV, arthritis (particularly in the knees, where this patient experiences it), is common. The glycoproteins contained in the viral envelope of the HIV particle (described in detail in my answer for Dr. Dieckhaus) have been shown to promote arthritis, with 51% of these cases occurring in the knees (Klatt, 2012). It may therefore be questioned whether this subject’s arthritis is HIV-related, making the close monitoring of her HIV even more important.

Although her diabetes is currently well-controlled, if it goes uncontrolled, this would count as a relative contraindication as well: “Uncontrolled metabolic disease (e.g., diabetes, thyrotoxicosis, or myxedema).”

Additionally, in November 2011, she fell down a flight of stairs, which resulted in pain or injury enough to warrant a cortisone shot. I will regard this as a possible relative contraindication (“Mental or physical impairement leading to inability exercise adequately”) as it may impair the ability to do activities that involve her knee.

Lastly, she should use her albuterol inhaler prophylactically 15 minutes prior to engaging in exercise.

1. What other healthcare professionals should you consult when designing her exercise prescription?

The other health care providers that should be included are her case manager at Connections. Often the case managers know more about the subjects’ personal lives that may affect exercise than I would (e.g., “I haven’t been sleeping well”, “I’m homeless again”, “I used drugs three days last week”, etc.). Her primary care physician (if she has one) should also be involved, as well has her HIV specialist (again, if she has one). Access to relevant medical information (e.g., “her CD4+ count is at 350”, etc.) would help me to predict risks of the engagement in exercise.

1. Formulate her FITT-VP exercise prescription including special considerations.

If she is cleared by her physician to participate in exercise, I will take this to mean there are no contraindications to exercise that would preclude her participation (i.e., her diabetes and arthritis are stable). I will also assume her physician has informed me that her CD4+ values are stable and she is not in a state of transition with her antiretroviral medications, which could alter metabolic functioning (as I described briefly on page 4 and would be happy to elaborate on in the oral exam).

For the first phase in the progression of her FITT-VP, I would have her perform aerobic exercise 3 days a week for 30 minutes at a VO2R of about 40%. This is the minimum suggested prescription in GETP8 for people with HIV. During this phase, I could closely monitor how she responds to the transition into exercise, however mild. If this does not exacerbate her asthma, arthritis, or an unforeseen complication with her HIV, I would increase the frequency and time before increasing the intensity. For the next 4 weeks, I would have her maintain the intensity of 40% VO2R, but increase the frequency to 4-5 days a week and the time spent in each exercising to 45 minutes (half way to the maximum daily recommendation). During this phase, we could also begin to incorporate light resistance training, stretching, and safe proprioceptive-neruomotor exercises that don’t include a risk of falling.

For this month in the progression, I would closely monitor her arthritis to make sure the frequency of use doesn’t exacerbate any symptoms. If it does, we could explore what is causing the flare up. Is it just the amount of exercise, or is it the type? For example, if we’re doing an incline treadmill, do the mechanics of the gait cause more pain than would a cycle ergometer? Or perhaps does the impact of the treadmill induce more discomfort than would an elliptical machine or laps in a pool?

At the end of this phase, 6 weeks would have elapsed, after which, I would have a much firmer idea regarding the safety of her involvement in exercise. According to Spence et al. (1990), this is enough time for resistance exercise to have resulted in statistically significant adaptations. According to Stringer et al. (1998), 6 weeks is sufficient time to achieve significant improvements via aerobic exercise. Although the progression of our exercise prescription would begin much more slowly than Stringer et al. and Spence et al., their studies only lasted 6 weeks whereas the active duration in Healthy Activities for Prize Incentives (HAPI) lasts 16, leaving us 10 weeks to change the mode of exercise and increase the intensity (up to 60% VO2R, from 40%) according to the safe capacity of the subject. This progression would err on the side of conservative, however.

Being as a variety of positive results have been found in both resistance exercise (see my answer beginning on page 1) and aerobic exercise (beginning on page 6), a combination of exercise modes, such as the program found in Grinspoon et al. (2000), who reported no adverse events throughout the 12-week intervention, would likely be what I chose to model the mode of my prescription after for the remaining 10 weeks (save for the isometric exercise testing). However, as noted by the special considerations in GETP8 (pg. 247), specific accommodations would have to be made throughout the course of the exercise prescription in response to day-to-day variations in the subject’s condition.