

# A Review of the Physiological Effects of Exercise Duration and Intensity during Walking and Jogging

*R.A. Awopetu*

Department of Human Kinetics and Health Education, University of Lagos

Email: [wptraphael@yahoo.com](mailto:wptraphael@yahoo.com)

## **Abstract**

*Jogging and walking are the most common aerobic exercises engaged in by numbers of people at different intensity and duration. This paper reviews research works on physiological effects of jogging at high intensity and walking for long duration. These include effects on cholesterol levels, blood glucose levels, cardiorespiratory fitness, weight loss, metabolic syndrome and flexibility. Past research works established that jogging which is at high intensity burns large amounts of calories and walking at long duration also burns calories and works muscles but at lower impact, making it easier on the joints, muscles and bones. Conclusively, the review submits that both forms of aerobic exercise, jogging and walking, are of great importance to human health but they differ in their levels of intensity and duration. Walking is a general form of exercise for everybody, both young and old regardless of their health status at certain duration while jogging is beneficial but should be prescribed and supervised*

**Key words:** Jogging, walking, intensity, duration.

## **Introduction**

Exercise is defined as any activity requiring physical effort, carried out especially to sustain or improve health and fitness, a task or activity done to practice or test a skill. Caspersen, Powell and Christenson (1985) also described exercise as a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective, the improvement or maintenance of physical fitness. Exercise is further defined as any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons including strengthening muscles and the cardiovascular system, honing athletic skills, weight loss or maintenance, as well as for the purpose of enjoyment. Frequent and regular physical exercise boosts the immune system, and helps prevent the "diseases of affluence" such as heart disease, cardiovascular disease, Type 2 diabetes and obesity (Stampfer *et al.*, 2000; Hu *et al.*, 2001).

Exercises are generally grouped into three types, depending on the overall effect they have on the human body (National Institutes of Health & National Heart, Lung and Blood Institute, 2006). The first group according to Wilmore & Knuttgen (2003) is aerobic exercise, which is any physical activity that uses large muscle groups and causes body to use more oxygen than it would while resting. The goal of aerobic exercise is to increase cardiovascular endurance. Examples of aerobic exercise include cycling, swimming, brisk walking, skipping rope, rowing, hiking, playing tennis, continuous training, and long slow distance training. The second group according to Wilmore & Knuttgen (2003) is anaerobic exercise, also called strength or resistance training; can firm, strengthen, and tone muscles, as well as improve bone strength, balance, and coordination (Wilmore & Knuttgen, 2003). Examples of strength moves are pushups, lunges, and bicep curls using dumbbells. Anaerobic exercise also includes weight training, functional training, eccentric training, interval training, sprinting and high-intensity interval training, these increase short-term muscle strength. The third group of exercise is the flexibility exercises stretch and lengthen muscles.

Activities such as stretching help to improve joint flexibility and keep muscles subtle. The goal is to improve the range of motion which can reduce the chance of injury (Wilmore & Knuttgen, 2003).

### **Exercise Intensity and Duration**

Exercise intensity according to King *et al.* (1995), refers to how much energy is expended when exercising. Perceived intensity varies with each individual. It has been found by King *et al.* (1995) that intensity has an effect on what fuel the body uses and what kind of adaptations the body makes after exercise. Intensity is the amount of physical power (expressed as a percentage of the maximal oxygen consumption) that the body uses when performing an activity (The President's Council on Physical Fitness and Sports, 2011). It is an indication of how fast and how hard you need to exercise while exercise duration gives an idea of how much time should be spent each day for the exercise (Otinwa, 2010). Heart rate can be an indicator of the challenge to the cardiovascular system that the exercise represents (Levine, 2007). Exercise is categorized into three different intensity levels by King *et al.* (1995) as low, moderate, and vigorous. The intensities are measured by the metabolic equivalent (METs). The effects of exercise are different at each intensity level (King *et al.*, 1995).

### **Jogging and Walking**

Jogging and walking belong to the aerobic exercise type but both differ in the level of intensity and time spent. Jogging according to Otinwa (2010) is a form of trotting or running at a slow or leisurely pace and falls into the category of vigorous intensity exercise while walking falls into the light intensity exercise with longer duration of time than jogging. Many people walk or jog almost every day as a form of exercise and relaxation. Some people feel it is better to jog, since the heart rate is elevated and you can potentially cover more ground in less time due to the faster pace. Walking is beneficial because you are burning calories and working your muscles but it is at a much lower impact, making it easier on the joints, muscles, and

bones. Jogging may also be used as a warm up or cool down for runners, preceding or following a workout or race. It is often used by serious runners as a means of active recovery during interval training. Jogging can be used as a method to increase endurance or to provide a means of cardiovascular exercise but with less stress on joints or demand on the circulatory system. Walking (also known as ambulation), on the other hand is one of the main gaits of locomotion among legged animals, and is typically slower than running and other gaits. Certain health benefits have been attributed to walking. These include increase in life expectancy even for individuals suffering from obesity or high blood pressure (Otinwa, 2010). It also improves bone health, especially strengthening the hip bone, and lowering the more harmful low-density lipoprotein (LDL) cholesterol, and raising the more useful good high-density lipoprotein (HDL) cholesterol (Yeager *et al.*, 2000; Brown *et al.*, 2002; Tolley & Rodney, 2003; Balish & Chris, 2006; Edlin *et al.*, 2007; Crawford, 2009). Studies further showed that walking may also help prevent dementia and Alzheimer's (Sydney Morning Herald, 2010).

Otinwa (2010) states that walking also improves appearance and posture, decreases waistline, increases self-confidence, positive attitude and positive feeling, increases the strength of the heart muscles, increases blood flow and volume, decreases total cholesterol, helps in weight control and improves muscular flexibility among others. The risk of injury is low for walking, everyone can do it, it burns calories, and it makes you fit and healthy (MedicineNet, 2014). Jogging yields the same benefits as walking, but there is more impact on your knees, hips, and other joints." Obviously walking is a slower pace than jogging, but it is seen as a safer alternative to jogging (MedicineNet, 2014). Anyone can walk, and everyone can vary their pace to something that is comfortable for them.

### **Review of Research Studies in Exercise Intensity and Duration**

The following research works focused on exercise intensity and duration were reviewed. Some of the studies identified effects of

high intensity-short duration exercise compared to low intensity-long duration exercise. The studies (Yeager *et al.*, 2000; Brown *et al.*, 2002; Tolley & Rodney, 2003; Balish & Chris, 2006; Edlin *et al.*, 2007; Crawford, 2009) reviewed used jogging as a high intensity exercise while walking was used as a long duration low intensity exercise. The works reviewed identified physiological effects of exercise intensity and exercise duration on cholesterol levels, Type II muscle fibres, cardiorespiratory fitness, weight loss or gain, and metabolic syndrome.

According to Chantal *et al.* (2003), in their review study on impact of exercise on cholesterol levels, they observed how exercise intensity reduces cholesterol level in both men and women. For men, data from exercise training studies and epidemiological studies support the existence of an exercise intensity threshold for increases in HDL-C levels (Yeager *et al.*, 2000; Brown *et al.*, 2002; Tolley & Rodney, 2003; Balish & Chris, 2006; Edlin *et al.*, 2007; Crawford 2009). Although exercise studies specifically designed to define such a threshold have not been conducted, many studies give a general idea of the intensity threshold observed to favorably increase HDL-C levels.

Several studies have suggested that the threshold for positive changes in HDL-C is an exercise intensity of 6 METs or more (21 ml/kg.min) (Leclerc, 1985, Lakka and Salomen, 1992). Leclerc *et al.* (1985) also reported that there were no further improvements in HDL-C levels when exercise intensity increased above 6 METs. Stein *et al.* (1990) reported significant increases in HDL-C levels in men that exercised at or above 75% heart rate maximum (HRmax), 3 times a week for 12 weeks. No changes in HDL-C were reported in the subjects that exercised at 65% HRmax. Stein *et al.* (1990) concluded that intensity of 75% HRmax or above is necessary to increase HDL-C levels in men. In addition, Kokkinos *et al.* (1995) studied 2906 men and reported that increases in HDL-C levels occurred in men jogging at an exercise intensity of 10 to 11 minutes per mile. Although a specific exercise intensity threshold has not been defined, it appears

that moderate intensity exercise is sufficient to raise HDL-C levels in men. In women, Kokkinos *et al.* (1995) found that exercise training studies attempting to assess the role of exercise intensity on HDL-C in women are few and report conflicting results. Most of the research suggests that women (pre and postmenopausal) with low levels of HDL-C are more likely to respond positively to exercise training. Duncan *et al.* (1991) reported similar increases in HDL-C levels in women (29-40 years) following 24 weeks of walking (4.8 km/session), regardless of intensity. This finding suggests that moderate exercise will raise HDL-C levels as much as intense exercise. In addition, Spate-Douglas and Keyser (1999) reported that moderate-intensity training over a 12-week period was sufficient to improve the HDL-C profile, and high-intensity training appeared to be of no further advantage as long as training volume (total walking distance per week) was constant. Conversely, Santiago and others (1995) reported no changes in HDL-C levels in women following 40 weeks of endurance training similar to the programme in Duncan's study.

According to American College of Sports Medicine (ACSM) (1984), during prolonged exercise at 60 to 75 percent of  $VO_{2max}$ , Type I fibers (red, slow-twitch) and Type IIa (red, fast-twitch) are recruited during the early stages of exercise, but as the intensity increases, Type IIb fibers (white, fast-twitch) must be recruited to maintain the same intensity. It requires more mental effort to recruit Type IIb fibers, and they produce lactic acid (ACSM, 1984). As the glycogen levels drop in the red muscle fibers, they rely more on fat (ACSM, 1984; Levine, 2008). Since fat is less efficient than carbohydrate, intensity will decrease (Levine, 2008).

### **Physiological Effects of Exercise Intensity and Long Duration on Cardiorespiratory Fitness and Weight Loss**

Chambliss (2005) carried out a research on exercise duration and intensity in a weight-loss programme in order to examine the effect of duration and frequency of exercise on weight loss and cardiorespiratory fitness in previously sedentary, overweight, women. At the end of the research, it was concluded that significant

weight loss and improved cardiorespiratory fitness were achieved through the combination of exercise and diet during 12 months, although no differences were found based on different exercise durations and intensities in this group of sedentary, overweight women.

A study of 201 overweight women published in the *Clinical Journal of Sports Medicine* found that longer duration exercise at a moderate intensity had a more profound effect on weight loss than training for less time at a higher intensity. Contrary to these submissions, Thompson *et al.* (1998) were of the opinion that low-intensity, long-duration exercise results in a greater total fat oxidation than does moderate intensity exercise of similar caloric expenditure, as seen in their research on "Substrate Use During and Following Moderate-and-Low-Intensity Exercise Implications for Weight Control".

TeroMyllymäki *et al.* (2012) in their study on effects of exercise intensity and duration on nocturnal heart rate variability and sleep quality where fourteen healthy male subjects (age  $36 \pm 4$  years, maximal oxygen uptake  $49 \pm 4$  ml/kg/min) performed five different running exercises on separate occasions starting at 6 p.m. with HR guidance at home. The effect of intensity was studied with 30 min of exercises at intensities corresponding to HR level at 45% (easy), 60% (moderate) and 75% (vigorous) of their maximal oxygen uptake. The effect of duration was studied with 30, 60, and 90 min of moderate exercises. Increased exercise intensity elevated nocturnal HR compared to control day ( $p < 0.001$ ), but it did not affect nocturnal HRV. Nocturnal HR was greater after the day with 90- than 30- or 60-min exercises ( $p < 0.01$ ) or control day ( $p < 0.001$ ). Nocturnal HRV was lower after the 90-min exercise day compared to control day ( $p < 0.01$ ). Neither exercise intensity nor duration had any impact on actigraphic or subjective sleep quality. The results suggest that increased exercise intensity and/or duration cause delayed recovery of nocturnal cardiac autonomic modulation, although long exercise duration was needed to induce changes in nocturnal HRV. Increased exercise intensity or duration does not seem to disrupt sleep quality.

Thompson (1998) findings supported this assertion in their report that low-intensity, long-duration exercise result in a total fat oxidation than does moderate intensity exercise with similar caloric expenditure.

### **Physiological Effects of Exercise Intensity and Long Duration on Metabolic Syndrome**

Laursen *et al.* (2012) in their prospective cohort study on intensity versus duration of physical activity: implications for the metabolic syndrome discuss that their analyses did not indicate any evidence of a beneficial effect of increasing walking volume whereas walking speed and jogging both, reduced metabolic syndrome risk after adjusting for volume of physical activity (*Lightweight Third Party Authentication*), thus supporting the perception that intensity plays a key role in metabolic syndrome prevention. In a cohort of 612 middle-aged men with assessment of both *Lightweight Third Party Authentication* and  $VO_{2max}$ , metabolic syndrome risk was lower at 4-year follow-up in men engaging in >3 h/week of moderate or vigorous *Lightweight Third Party Authentication* and in men in the upper  $VO_{2max}$  textiles (Sundström *et al.*, 2006). In a cross-sectional study of 1069 middle-aged men, cardiorespiratory fitness was inversely associated with metabolic syndrome whereas there was no effect of low-intensity activity (Lakka *et al.*, 2003).

Other study by Carrol and Dudfield (2004) and LaMonte *et al.* (2005) have confirmed cardiorespiratory fitness as a predictor of less progression towards the metabolic syndrome even in high-risk individuals. Similarly, Hassinen *et al.* (2010) found that high levels of cardiorespiratory fitness decreased the risk of developing metabolic syndrome and could even increase the probability of metabolic syndrome resolution in a population of 1226 men and women aged 57–78 years. In the Congenital Central Hypoventilation Syndrome, Schnohr *et al.* (2007) have previously shown that both jogging and walking speed rather than duration were protective of all-cause and cardiovascular disease mortality. A recent meta-analysis of walking



volume and pace on risk of coronary heart disease suggested a more pronounced dose-response protection effect for walking pace than walking volume (Zheng, Orsini and Amin, 2009). A similar meta-analysis by Hamer and Chida (2008) regarding the effect of walking on cardiovascular disease and all-cause mortality found that walking pace was a stronger predictor of overall risk than walking volume. Although the study did not point towards any association between duration of walking and metabolic syndrome risk, potential health benefits could still ensue from increasing walking volume. Regardless, it seems that increasing walking intensity rather than walking volume would be the sensible strategy in attempt to reduce metabolic syndrome risk.

Colberg *et al.* (2013), in their study on blood glucose responses to type, intensity, duration, and timing of exercise based on a prior big blue test, exercise choices were walking, running/jogging, cycling, conditioning machines, dancing, and other exercise (nonspecied). However, most exercise that are longer in duration reduces blood glucose levels and may require regimen changes to prevent hypoglycemia (Zisser *et al.*, 2011). In conclusion, varying types, intensities, and durations of exercise generally lower blood glucose levels in most individuals, although exercise of longer duration is likely most effective, and elapsed time since eating should be considered.

### **Physiological Effects of Exercise Duration and Intensity on Cholesterol Levels**

Santiago *et al.* (1995) reported no changes in HDL-C levels in women following 40 weeks of endurance training similar to the programme in Duncan's study. However, the women in Santiago's study had higher initial HDL-C levels than the women in Duncan's study (65 vs. 55 mg/dl). These findings also support that women with lower levels of HDL-C are more likely to see increases in HDL-C with exercise training. The research in postmenopausal women is also limited but provides positive results. Lindheim (1994) reported increased HDL-C levels in postmenopausal women that exercised at

70% HRmax for 24 weeks and were on hormone replacement therapy (HRT). Interestingly, no increases in HDL-C levels were reported for the exercise only group. This finding suggests a synergistic relationship between exercise and HRT. Similarly, Stein *et al.* (1993) found significant increases in HDL-C levels in postmenopausal women following 9-12 months of endurance training at 80-90% HRmax. In addition, King *et al.* (1995) assessed the effects of high and low intensity exercise programmes on HDL-C levels in sedentary women not receiving HRT. Although no significant increases in HDL-C were observed during year 1, by the end of year 2 subjects in both exercise groups showed small but significant increases in HDL-C levels. Interestingly, the increases were highest for subjects in the low-intensity group.

The authors suggested that this was a result of exercising more days per week and concluded that frequency of participation may be particularly important for increasing HDL-C levels in women. The results of these studies suggest that habitual low to moderate intensity exercise may increase HDL-C levels in postmenopausal women with or without HRT. Chantal *et.al.* (2003), submitted that the volume or amount of exercise performed per week may also influence the magnitude of change in HDL-C levels. Most of the exercise training studies identify a weekly mileage threshold of 7 to 10 miles/week for significant increases in HDL-C as was also suggested by Wood *et.al.* (1983) that a threshold of running approximately 8 miles per week over a 1-year period is necessary to increases in HDL-C levels. In addition, Williams (1982) reported that plasma concentrations of HDL-C generally did not begin to change until a threshold exercise level of 10 miles per week was maintained for at least 9 months. Kikkinos *et al.* (1995a) reported significantly higher HDL-C levels in runners that averaged 7 to 10 miles per week. An additional study by Williams (1998), suggested that exercise volume is more important than exercise intensity. He reported that weekly mileage was more strongly correlated to HDL-C levels than exercise intensity. Interestingly, a higher volume of exercise provided significant increases in HDL-C in a shorter period of time.

This indicates that there may be a relationship between exercise volume and the length of the training program. For non-runners a caloric expenditure above 1000 kcals per week has also been defined as a threshold dose of exercise to increase HDL- C levels (Drygas, 2000). These authors also noted that energy expenditure of 179; 2000 kcals per week is associated with additional increases in HDL-C and that there may be a dose-response relationship between exercise and HDL-C levels.

Also In women, the volume of exercise seems to be more important than the intensity of exercise for influencing HDL-C levels. Most studies suggest a large volume of exercise is necessary for significant HDL-C changes in women; however, the exercise volume threshold has not yet been defined. At the end of Chantal *et al.* (2003) study, they concluded that exercise prescription should involve continuous aerobic activities using large muscle groups. The exercise intensity should begin at a low to moderate level, depending on the fitness level of the client. As the client gains aerobic endurance intensity can be progressively increased. ACSM (1998) recommends an exercise intensity of 55-90% of maximal heart rate or 40-85% of heart rate reserve. The duration of activity will depend on the initial fitness level of the client and the client's preferred exercise intensity. The exercise prescription should begin with approximately 20 minutes of continuous exercise and may progress up to 60 minutes (ACSM 1998). Frequency The optimal training frequency appears to be 3 to 5 times per week (ACSM 1998). If a dose-response relationship between exercise and physical activity exists, it appears that clients should strive to exercise 5-7 days per week.

### **Conclusion**

Walking might not burn calories as quickly as jogging, but it's still a valuable way for many people to exercise (William McCoy, 2013). The University of Maryland Medical System reports that a 200-pound person burns about 426 calories during a 60-minute walk at 3 mph and 586 calories during a 60-minute walk at 4.5 mph. If you increase your pace to 5 mph, you're technically jogging, according to

Harvard Health Publications (2009). The higher tempo employ during a jog requires the body to push harder, which leads to more calories burned. According to the University of Maryland Medical System (2013), a person who weighs 200 pounds burns about 986 calories during a 60-minute jog at an average pace of 5.5 mph. If the same person increases that pace to 7 mph for 60 minutes, about 1,226 calories will be burned during the jog.

From the various works considered, it was deduced that both exercise intensity and long duration exercise are beneficial to the physiological activities of human but long duration exercise is of more importance. This can be substantiated by the following results: improved confidence, stamina, increased energy, weight control and higher life expectancy and reduced stress. It can also reduce the risk of coronary heart disease, stroke, diabetes, high blood pressure, bowel cancer and osteoporosis, among others. Since walking occurs at a brisk pace keeping one foot on the ground or treadmill at all times. Walking for a long duration increases heart rate, breathing heavily but not panting and causes perspire but not sweat heavily.

On a hot day walking up steep hills, one might reach a high heart rate that causes pant and sweat profusely and Jogging is a high-impact exercise because both feet are occasionally off the ground at the same time and body's entire weight hits the ground at once, landing on one foot each stride. Jogging takes place at a lower speed and heart rate than running. The point at which jogging becomes running depends on height, stride length and level of conditioning, jogging lets people in good condition continue without stopping for the duration of the workout. During jogging more energy is required and high in intensity, but not everybody can jog whether at low intensity or for long duration. When walking energy is also expended but at a slower pace and almost everybody can participate. So, we hereby submit that when prescribing exercise like drug, one must be careful and focus more on the benefit of a particular exercise to the client, based on physical components and most importantly the current status of the client.

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