Effect of carbohydrate ingestion during 'spin' classes on health and fitness parameters, quality of life and mood in recreational exercisers

– Happy Carb Study.

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Abstract

Background: Carbohydrate plays an important role in energy provision during exercise, and is a well-known performance-enhancing ergogenic aid. Carbohydrate ingestion has also been shown to influence mood and lead to more pleasurable feelings during exercise. However, carbohydrate ingestion especially from 'sugary' sports drinks is perceived to be detrimental for health and weight management. 'Spin' classes are popular group fitness cycling sessions where participants work at self-selected exercise intensities. Carbohydrate supplements may allow recreational exercisers to improve exercise performance and enhance the 'feel-good' aspects of exercise, leading to an improvement in health and fitness parameters, as well as mood. Extensive research has been conducted with well trained and/or elite athletes to examine the effects of carbohydrate ingestion during single bouts of exercise. However, studies on carbohydrate ingestion during single and repeated bouts of exercise, in recreational exercisers are lacking.

Aim: The primary aim of this study was to examine the effect of regular carbohydrate ingestion during exercise in a 10-week intervention on health and fitness parameters, mood and quality of life in recreational exercisers. A secondary aim was to examine the effect of 10-weeks of cycling exercise (spin classes) on health and fitness parameters, as well as quality of life.

Methods: Twelve recreational exercisers that attended regular spin classes volunteered to participate in this study. These participants in the Exercise cohort (EXE) were randomly allocated to either Carbohydrate (7.5% carbohydrate solutions; 5 mL/kg of body mass per exercise session; n = 6; CHO) or Placebo (0% carbohydrate, taste- and volume-matched solutions; n = 6; PLA) groups. They each underwent 2 x 45-minute spin classes per week, over a 10-week intervention period. Before each class, participants were given their allocated drinks to consume during the exercise class. Various heart rate parameters, as well as perceptual measures of exertion, pleasure-displeasure and activation (arousal) were assessed after each exercise session. Five non-exercisers were recruited for the Control group (age and gender-matched; CON); they continued their normal daily activities throughout the 10 weeks. All participants (n = 17) were required to attend pre- and post-intervention testing sessions where anthropometry, fat composition (BodPod), physiological measures (resting heart rate, resting blood pressure and oxygen saturation rate), cardiorespiratory fitness (cycling test; $\dot{V}O_2max$), quality of life (questionnaire), and various metabolic markers (via collection of blood samples) were assessed.

Results: There were no changes from pre- to post-intervention in the measures of body mass, fat composition, waist-to-hip ratio, body mass index (BMI), resting heart rate and systolic blood pressure, oxygen saturation rate, $\dot{V}O_2max$, metabolic markers (triglyceride, total cholesterol, low density lipoprotein and high density lipoprotein) and quality of life measures between CHO and PLA groups (all $p > 0.05$). However, a significant decrease in the resting diastolic pressure in the CHO group was observed post-intervention ($p = 0.02$). Throughout the 10-week intervention, mean heart rate, proportion of time spent in different heart rate zones, perceived working resistance, and perceptual ratings of exertion and pleasure-displeasure did not change between CHO or PLA groups (all $p > 0.05$). However, the level of activation throughout the intervention increased in CHO participants, while it decreased in the PLA group ($p = 0.03$). Furthermore, a higher proportion of participants within the CHO group were in the 'high-activation, pleasurable' quadrant (circumplex model of affect) throughout the intervention. The 2-hour fasted glucose ($p < 0.01$) and high density lipoprotein ($p = 0.04$) levels also significantly decreased in the CHO group, while it increased in the PLA group.

There were no differences in any health and fitness parameters between EXE and CON groups following the 10-week intervention (all $p > 0.05$) except for a decrease in waist-to-hip ratio of the EXE cohort, and an increase in the CON group ($p = 0.02$). Lower BMI ($p = 0.03$) and resting heart rate ($p < 0.01$), and higher cardiorespiratory fitness ($p < 0.01$) and 'work' subscale of quality of life ($p = 0.03$) were seen at baseline in the EXE cohort.

Conclusion: Carbohydrate ingestion during regular exercise over a 10-week period did not have any physiological benefits in recreational exercisers. However carbohydrate ingestion appeared to enhance 'feel-good' state of recreational exercisers throughout the intervention period. The 10 weeks of regular exercise did not incur any additional benefits relative to no exercise. Nevertheless, the exercisers showed better physiological and cardiovascular fitness relative to non-exercisers.

Keywords: Feeling Scale, Felt Arousal Scale, circumplex model.

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1.0 Introduction

Health is defined as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 2012). Therefore, the health of an individual depends not only on their physical wellness, but also their mental wellbeing, and regular exercise has been shown to benefit both. The benefits of regular exercise include prevention and reductions in the risk factors of certain life threatening, highly prevalent diseases, such as cardiovascular disease and obesity (Shepard & Balady, 1999; Hallstrand et al., 2000). The risk factors of cardiovascular disease decrease through exercise by the reduction of resting/exercising heart rate, blood pressure and myocardial oxygen demand, together with increased myocardial contractility (Shephard & Balady, 1999). Furthermore, exercise reduces obesity by metabolic influences, such as enhanced glucose tolerance, as well as improved lipid profile (Svendsen et al., 1993; Nybo et al., 2009). Accordingly, the risk factors for both cardiovascular disease and obesity have been found to improve with regular exercise (Svendsen et al., 1993).

In addition to the improvements in physical functions, mental benefits such as improved mood, decreased anxiety, depression and stress become evident with regular exercise (Wilcox et al., 2006; Edenfield & Blumenthal, 2011; Pasco et al., 2011). However, approximately 48% of New Zealanders over the age of 15 fail to participate in the recommended dose of exercise (Social Report, 2012).

A balanced diet, in conjunction with exercise, plays a huge role in the health and wellbeing of an individual. One of the essential macronutrient, carbohydrate, is an important substrate utilised for energy provision for the contraction of skeletal muscles, therefore plays a key role during exercise. However, popular diets such as the Atkins diet, restricts intake of carbohydrates (Astrup et al., 2004). The restricted carbohydrate intake has been associated with frequent complaints of headache, constipation, halitosis, muscle cramps, diarrhoea, general weakness and rashes (Sondike et al., 2003; Astrup et al., 2004). Furthermore, the symptoms of general weakness and rashes were more often reported on low-carbohydrate than on low-fat diets (Astrup et al. 2004). Consequently, carbohydrate plays a key role in several physiological functions such as digestion, and also influences the individual's mentality by inducing weakness and fatigue.

Carbohydrate is stored in the liver and muscle in the form of glycogen, and is broken down when plasma glucose level falls (Aragon-Varagas, 2000). Glucose is the main substrate for energy provision during exercise at moderate-to-high intensities (≥ 65% maximal oxygen uptake ($\dot{V}O_2max$)), and during short bursts of activity (Aragon-Varagas, 2000). The decrease in plasma glucose and depletion of stored glycogen has been shown to have detrimental effects on performance (Coyle et al., 1986). Therefore, the relatively small glycogen storage pool in the muscle and liver is a limitation in exercise performance (Ivy, 1999; Jeukendrup & Gleeson, 2004). As a consequence, manipulations of glycogen stores through changes in the diet have shown to benefit performance (Bosch et al., 1993). Carbohydrate has also been shown to affect mental states as blood glucose is the only fuel used by the cells of the central nervous system (Ivy, 1999). Manipulation of blood glucose by insulin clamps in Gold et al. (1995) showed that when glucose was decreased to the level of hypoglycaemia, a feeling of tense-tiredness persisted for 30 minutes after re-establishment of euglycaemia in healthy humans. Gonder-Frederick et al. (1989) have also shown that negative moods were associated with low blood glucose levels, while positive moods were associated with high blood glucose levels. A study of Quolla Indians in Peru (Bolton, 1973) showed that in those persons ranked as most aggressive, there was a tendency for their blood glucose levels to fall to low values during a glucose tolerance test. Similarly, tendencies to develop low glucose levels were seen in anti-social personalities (Linnoila et al., 1983). In addition to mood, glucose levels have also been associated with depression. De Castro et al. (1987) showed a negative relationship between the proportion of energy consumed as carbohydrate and the level of depression. A higher carbohydrate intake was also associated with feeling more energetic (Benton, 2002). When individuals were asked to rate their mood at midday, a positive association between carbohydrate intake in the morning and happiness was observed, while protein and fat intakes failed to show any associations with mood (Benton, 2002). Likewise, Benton & Owens (1993) found an increase in subjective mood by the measure of 'energy levels' at 14, 30 and 60 minutes after the ingestion of a sugar-containing drink and concluded that the changes in blood glucose levels were associated with fluctuations in mood. They also demonstrated that subjects whose blood glucose remained low reported greater tension than those whose blood glucose was higher. Consequently, studies show an association of higher plasma glucose levels with improved mood, more energy, and less tension (Benton & Owen, 1993; Achten et al., 2004).

The physiological importance of carbohydrate during exercise, in conjunction with its potential psychological effects, has led to studies examining the effects of carbohydrate ingestion during exercise, on exercise performance as well as several perceptual factors (Backhouse et al., 2007; Hulston & Jeukendrup, 2009). Acute studies of carbohydrate ingestion during single bouts of exercise have shown improvements in the cardiorespiratory fitness (El-Sayed et al., 1997; Hulston & Jeukendrup, 2009) as well as muscle endurance (El-Sayed et al., 1997; Haff et al., 2003). Possible mechanisms of action include sparing of glycogen (El-Sayed et al., 1997), or maintenance of carbohydrate oxidation rates (Nybo et al., 2009), which in turn allows improved control of glucose utilisation during exercise (El-Sayed et al., 1997). Furthermore, elevated plasma glucose levels following carbohydrate ingestion showed associations with perceived exertion and mood (Nybo 2003; Backhouse et al., 2007). The perceived exertion during the same relative intensity exercise was shown to be lower in several studies with carbohydrate ingestion (Fritzsche et al., 2000; Backhouse et al., 2005; Backhouse et al., 2007) which suggests an attenuation of central fatigue. Intake of a high carbohydrate diet (8.5 g/kg/day) showed performance and psychological benefits compared to a lower carbohydrate diet (5.4 g/kg/day) through an 11-day aerobic training intervention (Achten et al., 2004). In addition, more pronounced deteriorations of global mood scores were observed in the group that had lower levels of carbohydrate intake. Therefore, results of the studies suggest glucose affects the central nervous system and plays a role in changes of mood during exercise.

The Felt Arousal Scale (FAS; Svebak and Murgatroyd, 1985) and Feeling Scale (FS; Hardy and Rejeski, 1989) are commonly used in studies to examine the level of arousal and pleasure ratings, respectively, during exercise (Backhouse et al., 2007; Rollo & Williams, 2010; Ali et al., 2011). Carbohydrate intake during a high-intensity intermittent exercise in soccer players showed elevated perceived activation and pleasure ratings throughout the 90-minute exercise session (Backhouse et al., 2007). Both ratings measured after the exercise sessions were significantly higher in the last 30 minutes of the 90-minute exercise trial with carbohydrate ingestion when compared to the placebo group (Backhouse et al., 2007). On the contrary, Rollo & Williams (2010) found no difference in ratings of perceived activation or pleasure in a 1-hour treadmill run with carbohydrate ingestion in endurance-trained male runners. However, Rollo & Williams (2010) provided a high carbohydrate (86% of total energy intake) meal of high glycaemic index 3 hours prior to exercise. Elevated levels of glucose prior to the ingestion of carbohydrate during exercise may therefore have diminished the apparent benefits on mood. Overall, carbohydrate ingestion during exercise has shown potential to improve performance as well as have benefits in central fatigue and mood.

Studies investigating the effects of carbohydrate ingestion during single bouts of exercise have shown various benefits as mentioned above (Sallis et al., 1987; El-Sayed et al., 1997; Shepard & Balady, 1999; Backhouse et al., 2007; Hulston & Jeukendrup, 2009). However, studies examining the effects of carbohydrate ingestion during regular exercise sessions are lacking (De Bock et al., 2008;

Nybo et al., 2009). In a six-week intervention of carbohydrate ingestion during regular cycling sessions – whether in a fasted or carbohydrate loaded state – there was an increase of stored muscle glycogen levels in the carbohydrate loaded group only (De Bock et al., 2008). However, improvements in cardiorespiratory function were seen in both groups (De Bock et al., 2008). Furthermore, an eight-week training programme of intermittent cycling exercise improved cardiorespiratory fitness and reduced fat mass in both carbohydrate and placebo groups (Nybo et al., 2009). Both of the aforementioned studies show minimal evidence in the effects of regular use of carbohydrate. However, studies of De Bock et al. (2008) and Nybo et al. (2009) were conducted solely to observe the potential changes in metabolic factors involved in substrate utilisation, with regular use of carbohydrate ingestion. Therefore, to the author's knowledge, no study has examined the perceived activation and/or pleasure ratings throughout the duration of the intervention with ingestion of carbohydrate during regular bouts of exercise.

Carbohydrate drinks are recommended during training or competition for elite or competitive athletes (Jeukendrup, 2004). However, due to the negative connotations of 'sugary' drinks, they are not used as often by the recreationally exercising population (Bray et al., 2004). The majority of studies examining the effects of carbohydrate ingestion during exercise have targeted elite or trained athletes (Haff et al., 2003; Backhouse et al., 2005; Hulston & Jeukendrup, 2009). However the physiological differences between elite and recreational exercisers mean they have different requirements as well as demands during exercise. Therefore, further investigation is required to examine the effect of carbohydrate ingestion on recreational exercisers.

1.1 Aims

The primary aim of this study was to examine the effect of regular carbohydrate ingestion during a 10-week exercise intervention on health and fitness parameters, mood and quality of life in recreational exercisers. A secondary aim was to examine the effect of 10 weeks of cycling exercise (spin classes) on health and fitness parameters.

1.2 Hypotheses

H_o1: There will be no difference between the carbohydrate (CHO) and placebo (PLA) groups in the change in body mass, fat composition, body mass index (BMI), waist-to-hip ratio, resting heart rate and blood pressure, oxygen saturation rate, cardiorespiratory fitness, and metabolic characteristics following 10 weeks of cycling exercise.

H_o2: There will be no difference between the CHO and PLA groups in the mean heart rate, or the proportion of time spent in the different heart rate zones, during the exercise sessions throughout the 10-week intervention.

H_o3: There will be no difference between the CHO and PLA groups in the perceived working resistance, or the perceived exertion during the exercise sessions throughout the 10-week intervention.

H_o4: There will be no difference between the CHO and PLA groups in ratings of pleasure and perceived activation during the exercise sessions throughout the 10-week intervention.

H_o5: There will be no difference between the CHO and PLA groups in the ratings of the quality of life (QoL) throughout the 10-week intervention.

H_o6: There will be no difference between exercise (EXE) and control (CON) groups in the change in body mass, fat composition, BMI, waist-to-hip ratio, resting heart rate and blood pressure, oxygen saturation rate, cardiorespiratory fitness and metabolic characteristics from pre- to post-intervention.

H_o7: There will be no difference in ratings of QoL between EXE and CON groups following 10 weeks of cycling exercise.

2.0 Literature review

The primary aim of this literature review is to examine the use of carbohydrate drinks during exercise on the possible performance, physiological and perceptual benefits. A further aim is to outline the effect of exercise on health and fitness parameters, as well as mood and quality of life. The review will begin with the broader analysis of the effects of exercise and then lead on to the effects of carbohydrate ingestion during exercise to establish the context for the aims of this thesis.

2.1 Health

Globally, six percent of deaths are attributed to physical inactivity (American College of Sports Medicine; ACSM, 2012); this follows high blood pressure (13%) and tobacco use (9%; ACSM, 2012). In addition, an estimated seven million deaths per year are considered to be preventable by regular exercise (ACSM, 2012). Regular exercise has been associated with improved physical health and fitness (Fogelholm et al., 2000; Tully et al., 2005; Hammer et al., 2008), as well as psychological factors such as improved vitality, mood and quality of life (Fine et al., 1999; Kerksick et al., 2009). Combined improvements in physical health and fitness, as well as mental health, works to benefit the state of complete physical, mental, and social well-being of an individual (World Health Organisation; WHO, 2012).

Physical health relates to the physiological balance of the body and its biological systems. This would equate to having no disease or illness, nor any disabilities that would interfere with everyday living. Four of the top 10 leading causes of death: ischemic heart disease, stroke and other cerebrovascular diseases, chronic obstructive pulmonary disease and diabetes mellitus, are highly correlated to obesity as a risk factor (Chen et al., 1993; Haslam & James, 2005; Hammer et al., 2008). Obesity affects quality of life, contributes to the high mortality rate, and is a huge financial burden to the economy (Haslam & James, 2005). As of 2008, 1.5 billion adults over the age of 20 are considered overweight with a body mass index (BMI) of ≥ 25 kg/m^2 (WHO, 2012). Of these 1.5 billion adults, over 200 million men and nearly 300 million women are obese (BMI of ≥ 30 kg/m^2), and an estimated 2.8 million adults die each year as a result of obesity (WHO, 2012). Obesity also negatively influences a number of psychological factors such as low self-esteem, mood disorders, and also quality of life (Duval et al., 2006).

Mental wellness is related to the state of mind. The state of mental well-being in an individual is the realisation of their potential, the ability to cope with the normal stresses of life, work productively and fruitfully, and to contribute to the community (WHO, 2012). Furthermore, accurate perceptions of self, the world, and the future are thought to be essential for mental health (Taylor & Brown, 1988). Mental disorders are a major risk factor for communicable and non-communicable diseases and they also contribute to unintentional and intentional injuries, with approximately 800,000 people around the world committing suicide every year due to mental disorders (WHO, 2012). The stigma surrounding mental disorders and discrimination against patients, often prevents those with the disorders from seeking help (WHO, 2012). The majority of mental disorders are initiated from negative mood states of the individual (Schuch et al., 2011). Therefore, factors that enhance mood such as exercise has shown to benefit mental health (Lichtman & Poser, 1983; Wilcox et al., 2006; Pasco et al., 2011).

2.2 Exercise

Exercise and physical activity is defined as the contraction of the skeletal muscles to produce any bodily movements that require energy expenditure (ACSM, 2012). The importance of exercise and its effects were highlighted in the 18th century by Scottish physician Dr. William Buchan when he stated that, “Of all the causes which conspire to render the life of man short and miserable, none have greater influence than the want of proper exercise”.

2.2.1 Exercise Recommendations

Regular exercise is recommended for its benefits on physical and mental health (ACSM, 2012). The American College of Sports Medicine recommends at least 30 minutes of moderate-intensity physical activity (at intensities high enough to break a sweat, but still able to carry on a conversation) five days per week, or 20 minutes of more vigorous activity three days per week. In addition to aerobic training, two days of resistance training should be undertaken, with 8-12 repetitions of 8-10 different exercises that target all major muscle groups (ACSM, 2012).

Government organisations such as Sports NZ have been established to monitor and promote exercise participation, and just over 50% of the population were found to exercise regularly (Social Report, 2012). However, despite the positive physical and mental health benefits of exercise, long-term adherence to exercise programs remains problematic (Dishman, 1982). It is estimated that only 50% of all persons who initiate an exercise program continues the habit for more than 6 months (Dishman, 1982). In addition, most organisations promote exercise participation however fail to highlight the importance of regular participation (Perri et al., 1997).

2.2.2 Physiological benefits of exercise

Exercise has been associated with benefits in various aspects of health and fitness. Most importantly, it has been associated with marked reductions in the population of overweight and obese individuals.

Prevention from becoming overweight or obese is achieved by maintaining a balance between energy intake and energy expenditure (Haslam & James, 2005). The imbalance of energy intake and expenditure disrupts the equilibrium causing fluctuations in weight. The increase in the availability of energy dense fast-foods, combined with the decrease in energy expenditure from a sedentary lifestyle, disrupts the energy balance causing an increase in the likelihood of becoming overweight/obese (Sawkill et al., 2013). Kerksick et al., (2009) stated that a low-energy diet alone does not elicit weight loss, however when coupled with exercise, it allows for a greater positive outcome in its effect in the magnitude of weight loss. Despite Kerksick's statement, a low-energy diet has been associated with reduced body mass, blood pressure, body fat, plasma lipid levels and myocardial triglycerides (Svendsen et al., 1993; Hammer et al., 2000). Additional weight loss interventions controlling energy intake, were shown to be effective in studies by Shah et al. (1994) and Pasman et al. (1997). However, exercise has been shown to further enhance weight loss in addition to improvements in lipid profiles (Sallis et al., 1987; Svendsen et al., 1993; Shah et al., 1994; Fogelholm et al., 2000). A comparison between a diet-controlled group, and a diet and exercise-controlled group showed that the exercise group had significantly higher fat loss, lower resting blood pressure, improved lipid profile as well as increased resting metabolic rate (Svendsen et al., 1993). Furthermore, regular exercise increased 24-hour post-exercise energy expenditure (Melanson et al., 2001) with greater fat oxidation as a consequence of increased exercise intensity (Bohr et al., 1991; Phelain et al., 1997; and Pritzlaff et al., 2000). Therefore, the benefit in weight loss is not only through increased energy expenditure during exercise but also continued post-exercise.

In addition to weight loss, exercise has been associated with improvements in physiological factors (summarized in Table 2.1). These improvements work collaboratively to enhance cardiovascular function, working to decrease the risk factors associated with cardiovascular disease (CVD). Cardiovascular disease is the disorder of the heart and blood vessels, including coronary heart disease, cerebrovascular disease, raised blood pressure, peripheral artery disease, rheumatic heart disease, congenital heart disease and heart failure (WHO, 2012). Exercise sessions lasting approximately 27.2 minutes per day for 12-weeks have shown decreases in resting blood pressure, lower risk of stroke as well as increases in exercise performance (Tully et al., 2005). Moreover, exercising 1-2 hours a day, three days per week for six-weeks (De Bock et al., 2008), one hour per day, one day a week for 10-weeks (Jasnoski et al., 1981) and one hour a day, three days per week for 10-weeks (Hallstrand et al., 2000), showed improvement in cardiorespiratory functions. The improvements in cardiovascular fitness is suggested to be through increased stroke volume and/or contractility of the heart (Naumann et al., 2012), and positive correlations were reported between cardiovascular fitness and all risk factors of CVD (Sallis et al., 1987). Therefore, improvements in the cardiovascular fitness through exercise decreases the risk factors associated with CVD.

Table 2.1 Overview of the benefits of exercise.

Benefits of exercise	
↓	Body mass[N^]
↓	Fat composition[N^]
↓	Waist-to-hip ratio[N^]
↓	Resting heart rate[c]
↓	Exercising heart rate[c]
↓	Resting blood pressure[+N^]
↑	Resting metabolic rate[^]
↑	Myocardial contractility[+]
↑	Aerobic fitness[Dg+]
↑	Cardiorespiratory function[DN]

Jasnoski et al., 1981[D]; Simons & Birkimer, 1987[c]; Svendsen et al., 1993[^]; Fogelholm et al., 2000[N]; Hallstrand et al., 2000[g]; Tully et al., 2005[+];

Hallstrand et al. (2000) also showed improved aerobic fitness as well as ventilatory capacity through participation in 10 weeks of aerobic exercise. Cardiorespiratory capacity is the ability of the body to transport oxygen to the working muscle and the reduction of the capacity is often thought to be the first sign of CVD (Astrand & Rhyming, 1954). Cheng et al. (2002) also reported that being active was associated with higher cardiorespiratory fitness and respiratory functions. Therefore, exercise has been shown to be beneficial by improving cardiovascular, cardiorespiratory, aerobic and respiratory fitness in addition to decreasing the risk factors associated with CVD (Hallstrand et al., 2000; Cheng et al., 2002; Tully et al., 2005).

The studies showing benefits of exercise are based on participants that are sedentary (Simons & Birkimer, 1987; Tulley et al., 2005), obese/overweight (Svendsen et al., 1993; Fogelholm et al., 2000; Tully et al., 2005) and/or have conditions that are benefitted by exercise such as in participants with CVD (Miller et al., 1997) and asthma (Hallstrand et al., 2000). Therefore, potential bias may be present in the published articles on the effects of exercise. However, regular exercise has shown to prevent decline in fitness levels, which is also associated with decreased risk factors of CVD (Sallis et al., 1987).

2.2.3 Psychological benefits of exercise

Single (Lichtman & Poser, 1983) and regular (Wilcox et al., 2006; Pasco et al., 2011) bouts of exercise have been associated with enhanced mood and mental states. A 10-week walking programme involving 16 participants who completed a battery of psychological tests including Profile of Mood Status (POMS; Shachman, 1983), the State-Trait Anxiety Inventory (STAI; Speilberger et al., 1970) and a retrospective questionnaire regarding self-perception of change, showed an improvement in the exercise group while outcome measures remained constant or deteriorated in the control group who maintained their sedentary lifestyle (Blumenthal et al., 1982). Furthermore, a cross-sectional study by Pasco et al. (2011) examined the association between habitual physical activity, and both positive and negative moods using the Positive and Negative Affect Schedule (PANAS). Pasco et al. (2011) found positive affect scores were reduced with decreasing activity levels, but no association between negative affect scores and exercise were observed. Therefore studies support a relationship between higher levels of physical activity and better mood states.

The effect of exercise on mood is observed immediately after exercise, depending on intensity, and extended beyond the termination of exercise (Landers & Petruzzello 1994; Craft & Landers, 1998). In addition, positive mood affects were seen in all participants that exercised at 60% of their aerobic capacity regardless of age, gender or fitness level (Barton et al., 2012). The benefits were proposed to be due to decreased negative thinking, increased opportunities for social interaction, mastering of new skills and also the increase in the ‘happy’ hormones, i.e. endorphin and catecholamine, which all contributes to enhance mood (Barton et al., 2012). Furthermore, the cross-sectional examination of exercise volume and mood by Annisi (2012) showed a positive correlation between mood and volume of exercise. However, studies seem to support the influence of regularity of exercise rather than single bouts of exercise on mood. Lichtman & Poser (1983) examined the effect of single bouts of exercise on mood using the Lowlis Mood Scale (Green, 1962) and POMS. They reported that regular exercisers (who attended at least 2 group fitness classes per week) experienced overall enhancements in more of the mood scales than the control group that did not exercise regularly. The depression score was also significantly higher in the control group when compared to the experimental group. Accordingly, Hoffman & Hoffman (2008) showed mood enhancement after single bouts of exercise only in regular exercisers, whereas no changes were seen in individuals that did not exercise regularly. Increased vigour and lower post-exercise mood disturbances were also observed in ultra-marathon runners and regular exercisers, whereas no significant differences were observed in non-regular exercisers (Hoffman & Hoffman, 2008). This suggests regular exercisers are more sensitive to the changes in mood compared to sedentary individuals. Williams & Lord (1997) also found subjective measures of wellbeing improved in general fitness, general health, sociability, mood and outlook compared with before in participants that exercise regularly, whereas the control group (no exercise) reported little change during single bouts of exercise. Therefore, enhanced mood during single bouts of exercise seem to be more pronounced in individuals that participate in regular exercise which suggests accumulation effects of exercise on mood.

Several mechanisms have been proposed to explain the effect of exercise on mood. However, it is beyond the scope of this review to examine these in more detail and so the interested reader is referred to Chaouloff (1989) and Yeung (1996) for reviews on the topic. Serotonin, a neurotransmitter, has been associated with depression and fatigue, with chronically low levels of serotonin and norepinephrine being observed in patients with depression (Owens et al., 1994). Serotonin has also been associated with the effects of exercise on mood that called the 'serotonin hypothesis' (Owens & Nemeroff, 1994; Davis et al., 2000).The serotonin precursor, tryptophan (Trp) is thought to cross the blood brain barrier via the same transporter as the branched chain amino acids (Davis et al., 2000). Normally, Trp in the blood is bound to albumin. However free fatty acids (FFA) have higher affinity to albumin compared to Trp. Therefore, the increase in FFA during exercise elevates the concentration of free Trp in the blood causing an influx into the brain (Davis et al., 2000). Accordingly, serotonin level has been associated with central fatigue during exercise (Meeusen et al., 2006) and factors that dampen the increase in serotonin may have beneficial central effects during exercise. Following overall consensus' (Owens & Nemeroff, 1994; Davis et al., 2000; Meeusen et al., 2006), changes in the level of serotonin seems to have an effect on mood. However, a clear mechanism of action is yet to be established. Prescribed antidepressants are normally selective serotonin-reuptake inhibitors that are designed to prevent reuptake of serotonin by the neuron allowing a prolonged period of serotonin availability for heightened nervous system activity (Owens et al., 1994). Like serotonin, prescribed drugs also prevent degradation of norepinephrine or block its reuptake into the neuron. Exercise has been shown to mimic antidepressant mechanisms to the monoaminergic and noradrenergic systems (Van Hoomissen et al., 2004). Therefore, higher dose of exercise in mild to moderately depressed men and women was associated with greater reduction in depressive symptoms (Dunn et al., 2005). In addition, individuals who expended > 2,500 kcal per week had a 28% lower risk of developing clinical depression than individuals who expended < 1,000 kcal per week (Paffenbarger et al., 1994).

Studies have shown improvements in aerobic fitness with regular exercise (Jasnoski et al., 1981; Hallstrand et al., 2000; Tully et al., 2005). However the improved aerobic fitness and mood showed no significant correlation (Jasnoski et al., 1981). Moreover, self-perception was associated to participation in the physical fitness training programme but was not associated to changes in physical fitness (Jasnoski et al., 1981). Therefore, the changes in physiological factors that occur with regular exercise do not seem to influence mood during exercise. However, the overall consensus is in support of the positive benefits of exercise on improved mood states.

2.3 Energy metabolism during exercise

Fat, protein and carbohydrate are the three key macronutrients that are required by the body. They each have unique properties and play a different role in energy metabolism.

2.3.1 Fat, protein and carbohydrate

Fats are solidified lipids which are components that are soluble in organic solvents. They are composed of three-carbon glycerol backbone esterified with differing fatty acid compositions. Fat works as a protective barrier for vital organs such as the heart, liver, spleen, kidneys, brain, and spinal cord, as storage of fat-soluble vitamins A, D, E and K, and also works as an important constituent of cell membranes (Hawley et al., 2000). Furthermore, fat is the main substrate utilised during prolonged exercise (Hawley et al., 2000). It is stored as triglycerides in the muscles as well as adipose tissue (Stevenson et al., 2009). During exercise, the triglycerides are broken down into glycerol and free fatty acids. The oxidation of free fatty acids is required for energy provision, thus it is not an instant source of energy. Therefore, if the body was to rely solely on fat as its energy source, maximal performance would be limited to about 60% of $\dot{V}O_2max$ (Hawley et al., 2000). Due to the near unlimited supply of fats stored in adipose tissue, depletion of fat as an energy source is not thought to be a cause of fatigue (Hawley et al., 2000).

Proteins are amino acids linked together to form polypeptides. The different side chains give different properties to the amino acids. They have structural as well as functional properties, and are required for synthesis of body proteins and other metabolites (Aragon-Varagas, 2000). The proteins actin, myosin, tropomyosin and troponin play a key role in muscle contraction as they are the main contractile apparatus of the muscle (Lemon, 2000). In addition, they have central roles in the metabolism of many organs and tissues (Lemon, 2000). Protein contributes to 5-10% of the energy expenditure, and its building blocks, amino acids, are utilised as a precursor for glucose through gluconeogenesis in the liver (Aragon-Varagas, 2000). The small contribution of proteins in energy production is due to the lack of storage of amino acids. It requires the breakdown of skeletal muscles or tissues from the gut. The contribution may increase during glycogen depletion and some branched chain amino acids can also be oxidised directly for energy provision (Aragon-Varagas, 2000).

Carbohydrate consists of three different monosaccharides present in the diet: glucose, fructose and galactose. They have similar structures, however the different linkages give each monosaccharide their different characteristics. Glucose is the only substrate that can be oxidised in the muscle and therefore the other macronutrients must be converted to glucose in the liver before being utilised for energy production (Aragon-Varagas, 2000). Carbohydrates are stored as glycogen in the body and are stored in the liver (80 to 100 g) and in the skeletal muscles (300 to 900 g). Plasma glucose is tightly regulated by the liver and the body relies heavily on glycogen storage for energy provision during high intensity exercise (Romijn et al., 1993). Muscle glycogen and blood-borne glucose can provide a minimum of 130 kJ/min of energy during very high-intensity exercise (Jeukendrup & Gleeson, 2004). As glycogen depletes in the working muscle and the liver, decreases in plasma glucose occur which can impact on performance and lead to fatigue (Aragon-Varagas, 2000; Jeukendrup & Gleeson, 2004).

2.3.1 Factors affecting substrate utilisation

Substrate utilisation during exercise depends on exercise intensity, duration, fitness level and nutritional status (Jeukendrup, 2010). Low intensity exercise is predominantly supported by the free fatty acids in plasma, and the proportion of fat to carbohydrate utilised for energy decreases with increasing intensity. At 25% of $\dot{V}O_2max$, fat is the predominant substrate; at 40% $\dot{V}O_2max$, fat and carbohydrate provide relatively similar amounts of energy, and carbohydrate becomes the predominant substrate at intensities above 65% $\dot{V}O_2max$ (Wagenmakers, 1989). Furthermore, fat is the predominant substrate utilised in exercise of durations longer than 20 minutes at moderate intensity (Romijn et al., 1993). With training, adaptations such as increased size and number of mitochondria and blood capillaries are seen (Phelain et al., 1997). This allows for greater aerobic oxidation, causing a gradual shift to an increased reliance on fat as fuel, which decreases the reliance on the limited supply of carbohydrate (Phelain et al., 1997). Improved capillarisation of the muscle also allows enhanced oxygen transport to the working muscle (Phelain et al., 1997). Although fat stores are unlimited, detrimental effects on performances are seen when muscle glycogen stores are depleted (Bergstrom et al., 1967) and higher levels of stored muscle glycogen have been associated with performance benefits (Phelain et al., 1997).

2.4 Carbohydrate

As discussed in Section 2.3, carbohydrates play a crucial role during exercise. However the relatively small storage of glycogen in muscle and liver has shown to be a limiting factor in exercise performance (Phelain et al., 1997). Approximately 20% of carbohydrate consumed was converted to muscle glycogen, and 12% was oxidised three hours post-ingestion of a meal after an overnight fast (Chryssanthopoulos et al., 2004). The 67% of carbohydrate ingested unaccounted for was assumed to be stored as liver glycogen and/or stored in the gastrointestinal tract for further digestion.

2.4.1 Negative connotations of carbohydrate intake

The increased consumption of 'sugary' drinks has been associated with the rise in obesity (Bray et al., 2004) and reported to have detrimental effects on dental health (Coombes, 2005). However, carbohydrate is important during exercise and also plays an important role in the function of the central nervous system (CNS), as blood glucose is the only fuel used by the cells of the CNS (Sokolof, 1981; Winnick et al., 2005). Despite the importance of carbohydrate, diets restricting carbohydrate intake, such as the commonly known Atkins diet, has increased in popularity (Astrup et al., 2004). The diet recommends regular exercise, with mineral and vitamin supplements, and an intake of less than 20 g of carbohydrate per day mainly in the form of salad greens and other non-starchy vegetables. The diet does not restrict protein and fat intake (Astrup et al., 2004). However, the Atkins diet has been associated with frequent complaints of headache, and constipation due to lack of fruit, vegetables and whole-grain breads and cereal intake (Sondike et al., 2003). In addition, reports of halitosis, muscle cramps, diarrhoea, general weakness and rashes were more often reported on the low-carbohydrate diets than on low-fat diets (Astrup et al. 2004). The weight losses were due to the decreased overall energy intake, and 1-year follow up study showed weight regain and increased frequency of depression (Stem et al., 2004). Boden et al., (2005) found that decreased carbohydrate intake resulted in a spontaneous reduction in energy intake, which consequently caused a decrease in weight loss. In addition, the decreased carbohydrate intake caused a reduction in leptin which may have had the effect of stimulating appetite to limit a diet-induced weight loss. The long-term adherence to the low-carbohydrate diets are poor and reduced fibre intake is thought to have adverse long-term health effects such as colon cancer (Sondike et al., 2003; Astrup et al., 2004; Boden et al., 2005). Stem et al. (2004) also showed that when compared to the conventional-diet group, the low-carbohydrate group's energy intake was approximately 400 calories lower than the conventional diet group. This study also showed that even with lower reported intake, the two groups did not differ in their weight loss. In addition, the low-carbohydrate group showed significantly higher blood urea nitrogen levels compared to the conventional-diet group which is cause by higher protein breakdown (Stem et al., 2004). Carbohydrate restricted diet therefore show evidence of weight loss, however these losses are most likely due to the decreased energy intake, not the effect of carbohydrate per se. In addition, low carbohydrate diets have shown detrimental effects on psychological states and mood (Achten et al., 2004; White et al., 2007). The popularity of the Atkins diet has reinforced the negative connotation of carbohydrate intake (Astrup et al., 2004). However, the detrimental effects of low carbohydrate intake are not well known. Apparent weight-loss, although not specifically through decreased carbohydrate intake, has individuals decreasing the intake of carbohydrate (Astrup et al., 2004).

2.4.2 Carbohydrate intake and glycogen stores

Manipulations in the diet to increase glycogen storage for performance have shown positive results in many studies (Bosch et al., 1993; Tarnopolsky et al., 1995; Achten et al., 2004). As early as 1939, Christensen provided clear evidence of the effect of carbohydrate diets on exercise, where a higher carbohydrate meal preceding exercise significantly improved endurance time to fatigue. Bergstrom & Hultman (1966) furthered the findings with a muscle biopsy, where lower muscle glycogen was associated with decreased performance, it was concluded that increased muscle glycogen levels improve performance. The consumption of three different isoenergetic diets for three consecutive days influenced glycogen storage as well as performance (Achten et al., 2004). The lowest glycogen storage was associated with the shortest time to fatigue, and highest glycogen storage associated with longest time to fatigue (Achten et al., 2004). Therefore, studies indicate that the level of stored carbohydrate (as glycogen) influences exercise performance.

Carbohydrate loading has been implemented to increase the level of stored muscle glycogen to improve performance (Tarnopolsky et al., 1995; Achten et al., 2004; Hargreaves et al., 2004; Rollo & Williams 2010). Consumption of a high carbohydrate meal for 11-days (~65% energy intake from carbohydrate) compared to the control group (~45% energy intake from carbohydrate) maintained exercise performance in the 16-km running time trial while a pronounced deterioration of performance was observed in the control group (Achten et al., 2004). However, both high-carbohydrate and control groups failed to prevent the deterioration of performance in an 8-km run time trial when compared to baseline performance measures (Achten et al., 2004). Furthermore, Sherman et al. (1993) failed to show any benefits following high (84% energy intake from carbohydrate) relative to moderate (42% energy intake from carbohydrate) carbohydrate intake in either cycling or running in a 7-day training study. Fairchild et al. (2002) also showed that muscle glycogen stores can also be increased within 24 hours by exercising at near maximal-intensity exercise with carbohydrate intake of 12 g/kg. Therefore, recent studies indicate that several days of diet manipulations are unnecessary to increase muscle glycogen stores for improved performance.

2.4.3 Carbohydrate ingestion during exercise

Studies examining acute ingestion of carbohydrate during exercise have shown performance benefits (El-Sayed et al., 1997; Nybo et al., 2003; Winnick et al., 2005). A cross-over study testing the effects of carbohydrate ingestion on trained male cyclists showed a higher mean power output and distance covered in a 1-hour performance ride with ingestion of 8% carbohydrate solution when compared to the placebo (El-Sayed et al., 1997). In addition, the voluntary force production after 3 hours of cycling was higher with 6% carbohydrate ingestion, when compared to placebo (Nybo et al., 2003). Both El-Sayed et al. (1997) and Nybo et al. (2003) showed that ingestion of carbohydrate increased plasma glucose concentrations. However, the glucose concentration decreased significantly in both the carbohydrate and placebo groups after the 1-hour performance ride (El-Sayed et al. 1997), whereas the decrease was only evident in the placebo group in Nybo et al. (2003). The participants in Nybo et al. (2003) ingested the carbohydrate every 15 minutes whereas only a single ingestion at the beginning of the exercise session was provided by El-Sayed et al. (1997). Therefore, the difference in the amount of carbohydrate ingested throughout the exercise session may have contributed to the disparities between the two studies. Furthermore, El-Sayed et al. (1997) examined the effect of carbohydrate in a 1-hour performance ride whereas Nybo et al. (2003) examined the effects during 3 hours of cycling. High carbohydrate oxidation was shown to be associated with higher intensity exercise (Phelain et al., 1997). Consequently, studies suggest improved performance was due to the increased availability and utilisation of glucose, leading to the sparing of muscle glycogen (Colye et al., 1986). In a carbohydrate loaded state, improved performance was associated with higher total muscle glycogen utilisation (Bosch et al., 1993). Consequently, the proposed mechanism of carbohydrate ingestion on performance enhancement is through prevention of glycogen depletion by the increases in the utilisation of plasma glucose. In addition, carbohydrate ingestion was suggested to modulate the effect of exercise on metabolic gene expression that alters substrate utilisation (Cluberton et al., 2005). Carbohydrate ingestion (6% CHO solution) during 60 minutes of cycling at 74% $\dot{V}O_2$max increased proteins associated with the rate limiting step of carbohydrate utilisation (Cluberton et al., 2005). In addition, Civitarese et al. (2007) showed that carbohydrate ingestion decreased expression of genes involved in fat transport and oxidation during a single bout of 2-hour moderate intensity cycling. Therefore, this enhanced utilisation of carbohydrate during exercise maintains or improves performance as exercising relying solely on fat limits maximal performance to about 60% $\dot{V}O_2$max (Hawley et al., 2000). On the contrary, De Bock et al. (2008) observed an increase in proteins associated with fat oxidation with carbohydrate ingestion. However, this did not influence the rate of fat oxidation (De Bock et al., 2008). Metabolic factors have also shown to be influenced by carbohydrate ingestion and may influence performance however more research is required in this area to clearly present evidence based conclusions.

On the contrary, Kambis & Sheets (2005) did not show improved time-trial cycling performance with ingestion of 12% carbohydrate although it was ingested every 15-minutes throughout the exercise session. Furthermore, exercise time to fatigue (CHO: 68.1 min; Con: 69.6 min)did not differ between the carbohydrate and placebo groups in McConell et al. (2000) when ingesting 6% carbohydrate at the start and every 15 minutes throughout. The results from these trials suggested potential placebo effects of carbohydrate ingestion. However, Hulson & Jeukendrup (2009) examined this aspect by testing the effect of carbohydrate, placebo and water ingestion while the carbohydrate and placebo groups were told that both drinks contained carbohydrate in order to try and eliminate the potential 'placebo effect'. Nonetheless, time trial performances in the carbohydrate group were significantly better than both the placebo and water groups. Accordingly, the improved performance does not seem to be due to a 'placebo effect'. In addition, during steady state cycling, carbohydrate ingestion increased glucose turnover rate and although overall oxidation of carbohydrate and fats were similar, performance enhancements were seen in the carbohydrate group (Febbraio et al., 2000). Therefore, the increased carbohydrate availability improved performance (Febbraio et al., 2000).

2.4.4 Carbohydrate ingestion before and during exercise

Increasing stored glycogen through carbohydrate loading, and carbohydrate ingestion during exercise has shown independent benefits on performance. However, studies show no effects in performance when the two methods are combined. Comparison of the ingestion of carbohydrate between a carbohydrate loaded group and normal group showed no performance benefits in a 100-km cycling time trial (Burke et al., 2000). In addition, total muscle glycogen utilisation did not differ between the two groups. Therefore, Burke et al. (2000) proposed that carbohydrate ingestion during exercise may offset any detrimental effects on performance of lower pre-exercise muscle and liver glycogen stores (Burke et al., 2000). On the contrary, Bosch et al. (1996) found that higher proportion of participants that exercised in a non-carbohydrate-loaded state could not complete 3 hours of cycling at 70% $\dot{V}O_2max$ although carbohydrate was provided during exercise. Total carbohydrate oxidation during exercise and blood glucose was similar between carbohydrate loaded and non- carbohydrate loaded groups. However, muscle glycogenolysis decreased after 60 minutes of exercise in the non-carbohydrate loaded groups. As the rates of blood glucose oxidation were the same, Burke et al. (2000) concluded that the high initial muscle glycogen levels in the carbohydrate loaded group increased endurance performance by postponing muscle glycogen depletion rather than sparing of stored glycogen. In summary, increasing stored muscle glycogen through carbohydrate loading show performance benefits. However adjustments in the dietary intake provide difficulty due to time commitments. The majority of the evidence show carbohydrate ingestion during exercise compensates for the low muscle glycogen levels and improves performance, which in turn suggests carbohydrate ingestion during exercise is sufficient in improving performance.

2.5 Exercise and mood

As mentioned in Section 2.2.3, mental health has a key role in the state of overall health, with mood playing an important role in influencing mental state (WHO, 2012). For this reason, recent studies have begun focusing on the mental aspects of exercise, and factors influencing mood during exercise (Achten et al., 2004; White et al., 2007).

2.5.1 Methods of assessing psychological states during exercise

Due to the complex nature of mood, different scales have been produced to assess the effects of acute bouts of exercise on mood. The Exercise-Induced Feeling Inventory (EFI; Gauvin & Rejeski 1993) is a multidimensional analysis of feelings supported by confirmation factor analysis. It consists of 12 items that captures four feeling states of revitalisation, tranquillity, positive engagement, and physical exhaustion (Gauvin & Rejeski 1993). This scale has shown accurate internal consistency, is sensitive to exercise interventions, appears responsive to the different social contexts in which activity may occur, and has been utilised by studies to test the effects of exercise (Gauvin & Rejeski, 1993; Annesi & Mazas 1997). However, the EFI lacks a subscale that assesses negative feeling states. A more global measure of exercise-induced feeling states was proposed by McAuley & Courney (1994) called the Subjective Exercise Experience Scale (SEES). It is a three-factor scale, where two factors correspond to positive and negative poles associated with psychological health, positive well-being and psychological distress, while the third factor corresponds to a subjective indication of fatigue (McAuley & Courney, 1994). The SEES consists of 46 subjective states with scales ranging from -5 (large decrease) to +5 (large increase). Although global measures are taken, the SEES lacks the measure of tranquillity and revitalisation (Lox et al., 2000) which led to the production of the Physical Activity Affects Scale (PAAS) with four subscales (positive affect, negative affect, fatigue, tranquillity) of affect, each with three items that are measured with scales ranging from 0 to 4 (Lox et al., 2000). This questionnaire was created as a combination of the EFI and SEES, and was shown to encompass measures of exercise-induced feeling states.

However, due to the length of these aforementioned questionnaires, the use of the Feeling Scale (FS) (Hardy and Rejeski, 1989) and Felt Arousal Scale (FAS) (Svebak and Murgatroyd, 1985) during exercise have recently increased. Rejeski et al. (1987) produced a simple 11-point single item scale (FS) that assessed the pleasure–displeasure score of emotions. The scale is easy-to-understand, and has an underlying presumption of affects as bipolar therefore has uni-dimensional properties. Studies have validated the scale and have measured changes in FS with exercise (Backhouse et al., 2007). In addition, the Felt Arousal Scale (FAS), also a single item with scales ranging from 1 (low arousal) to 6 (high arousal), has been utilised to measure the levels of arousal/activation of an individual (Svebak & Murgatroyd, 1985). Due to the simplicity and validity of the FS and FAS, they have been utilised together in studies to assess affective valence and active dimensions with exercise (Hall et al., 2002; Backhouse et al., 2007; Parfitt et al., 2010). Repeated measures of the two scales allow the use of circumplex models to analyse the changes in pleasure and activation (Russell, 1980). As depicted in Figure 2.1, the pleasure and activation can be represented in four quadrants. The 'feeling states' associated with the four quadrants are as follows; 'high-activation, displeasure' quadrant with tension, distress, nervousness and jitteriness; 'high-activation, pleasure' with energy, vigour, excitement and revitalisation; 'low-activation, displeasure' with tiredness, boredom, fatigue and lethargy; low-activation pleasure with calmness, relaxation, tranquillity and serenity (Ekkekakis et al., 2011).

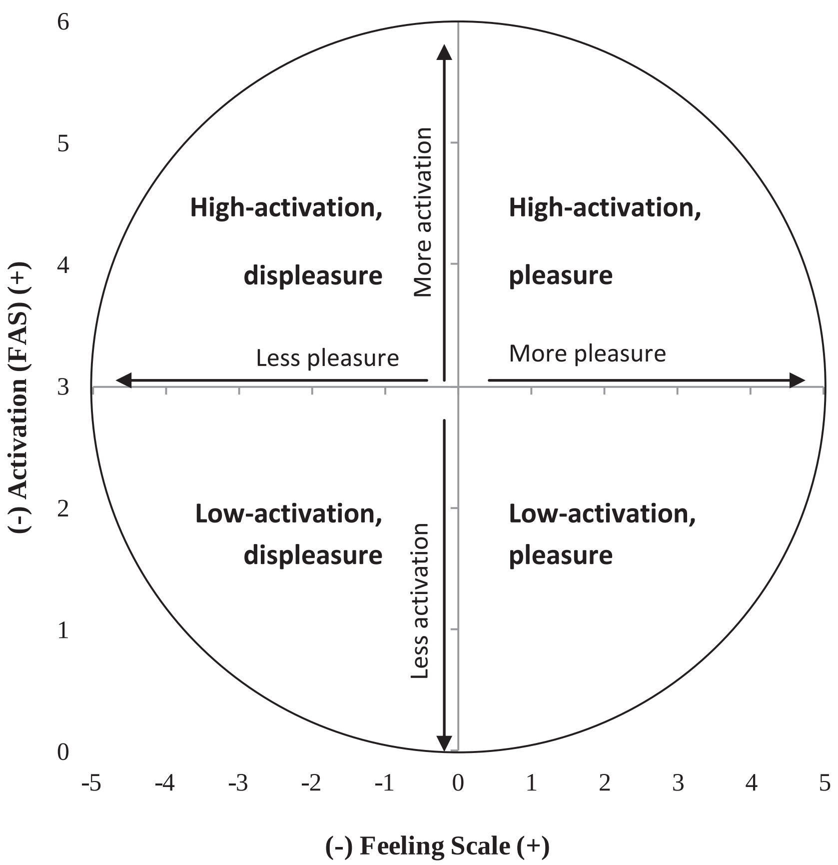


Figure 2.1 A visual depiction of the circumplex model used for plotting the perceptual responses to exercise (Ekkekakis et al., 2000).

Several studies (Hall et al., 2002; Backhouse et al., 2007; Parfitt et al., 2010) have measured pleasure-displeasure and activation while participating in single bouts of exercise with accompanying carbohydrate ingestion. However, no exercise intervention studies have used the circumplex model to examine changes in affect throughout several bouts of exercise.

2.5.2 Glucose level and mood

Studies have shown that plasma glucose levels play a role in the mental state of an individual (Bolton, 1973; Linnoila et al., 1983). An observational study by Bolton (1973) of the Quolla Indians in Peru showed a sharp decrease in blood glucose during the Glucose Tolerance Test (GTT) in those ranked to be most aggressive. In addition, the control of the blood glucose levels of offenders who had committed one or more severe violent assaults, showed abnormally high blood glucose levels in GTT, which then fell to particularly low values followed by a slow recovery (Linnoila et al., 1983). Tendencies to develop low glucose levels have also been shown in anti-social personalities (Linnoila et al., 1983). Therefore, low blood glucose levels were shown to be associated with aggressive behaviour. De Castro et al. (1987), using dietary records showed a significant negative relationship between the proportions of energy consumed as carbohydrate and depression. A higher intake of carbohydrate was also associated with feeling more energetic. In addition, 686 individuals were asked at midday to report their mood and what they had eaten that morning. The more carbohydrate that the participants had consumed, the happier participants felt during the morning. Protein and fat were found to have no associations with mood (Benton, 2001). Furthermore, Benton & Owens (1993) found that subjective ‘energy’ increased after consumption of a sugar-containing drink when mood was measured 14, 30 or 60 minutes after ingestion. Three cognitive tasks were tested which showed an association with falling blood glucose and falling levels of subjective energy

(Benton & Owens, 1993). Benton & Owens (1993) also demonstrated that subjects whose blood glucose remained low reported greater tension than those whose blood glucose was higher. Negative mood states have also been associated with low blood glucose in insulin-dependent diabetics, whereas positive moods tend to be related to higher levels of blood glucose (Laurenzi et al., 2011). This was also evident in healthy individuals when insulin clamps were used to induce hypoglycaemia, participants showed tense-tiredness persisting for 30 minutes after establishment of euglycaemia (normal blood glucose levels; Gold et al., 1995). Therefore, studies show associations between low glucose levels and negative moods.

2.5.3 Carbohydrate meals on mood during exercise

A low-carbohydrate diet consumed for two weeks was associated with higher fatigability and an elevated perceived exertion score when compared to a normal diet during 90-minute walking exercise at 50-79% HRmax (White et al. 2007). In addition, blood ketone concentrations were directly related to feelings of fatigue and to total mood disturbance while exercising (White et al., 2007). Consequently, increased fatigue and mood disturbance may work as an obstacle to the individuals desire to exercise. Furthermore, throughout an 11-day trial with participants consuming a high-carbohydrate diet (~65% energy intake from carbohydrate) or control (~45% energy intake from carbohydrate), deterioration of the global mood scores were dampened in the high-carbohydrate group throughout the trial (Achten et al., 2004). Consequently, changes in the carbohydrate intake through adjustments to the diet have shown to affect mood and perceived exertion during exercise.

2.5.4 Carbohydrate ingestion during exercise and effects on mood

Enhanced mental states wereobserved in exercise studies conducted to examine the performance benefits of carbohydrate ingestion (Butki et al., 2003; Backhouse et al., 2005; Peacock et al., 2011). Carbohydrate ingestion was shown to bring about perceptions of better overall mood, less fatigue, and greater vigour in response to exercise when compared to the placebo group (Butki et al., 2003). Backhouse et al. (2005) also showed elevated ratings of pleasure in the carbohydrate group, which continued 15 minutes post-exercise. Progressive enhancement in mood throughout a 1-hour intermittent high-intensity shuttle running was seen with carbohydrate ingestion over time (Winnick et al., 2005). In addition, Peacock et al. (2010) examined the effect of *ad libitum* ingestion of carbohydrate-electrolyte solution on psychological function and affective psychological responses to exercise by the FS and Ratings of Perceived Exertion (RPE). The pleasure ratings decreased from the onset of exercise in the water group, whereas increases were seen in the carbohydrate-electrolyte group (Peacock et al., 2010). Significantly greater pleasure ratings throughout the protocol were also observed in the carbohydrate-electrolyte group when compared to the water group (Peacock et al., 2010). In addition, the differences between the two groups were most significant during self-selected intensity exercise. However, no significant difference in the RPE was observed between the two groups (Peacock et al., 2010). Therefore, RPE measures show both groups perceived to be working at similar intensities however with carbohydrate-electrolyte solution, participants felt more active and pleasurable throughout the exercise session.

Backhouse et al. (2007) observed consistent RPE in the last 30 minutes of the 2-hour bouts of exercise in the carbohydrate group (6.4% carbohydrate solution provided at 5 mL/kg of body mass (kg BM)). However, the placebo group showed an increase in RPE which was accompanied by decreases in plasma glucose. In accordance with the serotonin hypothesis (Davis et al., 2000; Section 2.2.4), decreased glucose delivery to the brain may have triggered central fatigue, increasing the perceived exertion, whereas the glucose availability in the carbohydrate group may have attenuated this increase. Carbohydrate ingestion attenuates increases in free fatty acids with exercise (Hargreaves et al., 2004), and prevents the increases in free tryptophan available to cross the blood brain barrier (Davis et al., 2000). Consequently, the decrease in plasma glucose reported by Backhouse et al. (2007) may have caused increases in free tryptophan concentration leading to elevations of serotonin levels in the brain, leading to the increase in RPE.

On the contrary, one-hour maximal running performance with 6.4% carbohydrate provided at 8 mL/kg BM (Rollo & Williams, 2010) did not show any significant difference in RPE, FS or FAS ratings between carbohydrate and placebo. This may be due to the pre-exercise meal that replenished depleted glycogen stores and increased plasma glucose levels to a sufficient extent that the ingested carbohydrate did not have an effect. Furthermore, McConell et al. (2000) found no performance improvements in time to exhaustion with 6% carbohydrate ingested at 7 mL/kg BM during exercise. The participants of McConell et al. (2000) also had a high carbohydrate meal prior to their exercise session. McConell et al. (2000) proposed that the use of performance measures in time to exhaustion, compared to the majority of the other studies that conducted a time trial, may have influenced the results.

The majority of the aforementioned studies have been based on either a controlled diet for several days, followed by exercise testing with carbohydrate ingestion or the effect of acute use of carbohydrate ingestion (Backhouse et al., 2005; De Bock et al., 2008; Rollo & Williams, 2010). However, studies examining the effects of regular use of carbohydrate ingestion are lacking. An interventional study examining the effects of carbohydrate ingestion was conducted by Nybo et al. (2009). They examined the use of regular carbohydrate intake on physiological functions as well as influences on the transcription of metabolic genes. Increases in the proteins regulating glucose uptake to the cell were significantly higher in the placebo relative to the carbohydrate group. In addition, a larger increase in the proteins involved in fat metabolism was observed in the control group. However, Nybo et al (2009) failed to show a significant effect of carbohydrate on maximal oxygen uptake and peak power output during the incremental cycling protocol. Furthermore, Nybo et al. (2009) did not measure changes in mood or perception. Based on the effects of carbohydrate ingestion during single bouts of exercise on mood and perceptual factors, same benefits could be seen with regular exercise (Hopkins, 2012). Therefore, it would be interesting to examine the potential accumulative effects of prolonged use of carbohydrate drinks during regular exercise on psychological (as well as physiological) effects.

2.6 Recreational exercisers

In 2006/2007, more than 50% of the NZ population over the age of 15 reported that they exercised five or more days a week for 30 minutes a day (Social Report, 2010). Furthermore, participation of exercise through health clubs is a popular mode of exercise as it was found to be the fourth highest participated activity (Sports NZ, 2007/2008). Health clubs provide equipment for exercise indoors in the convenience of their own time, as well as group fitness classes. Health clubs were also reported to provide positive social interactions and the enjoyment of exercising with the other members which promoted regular exercising habits (William & Lord, 1997; Andersen et al., 1999; Wilcox et al., 2006; Barton et al., 2012).

2.6.1 Group fitness classes

Group fitness classes are becoming more popular throughout the world and LesMills offers a variety of fitness programmes in 80 countries worldwide (LesMills website). They offer 10 different classes ranging in duration from 30 to 60 minutes, with varying exercise intensities. The 'RPM' or 'Spin' class is a 45-minute long, indoor group cycling fitness activity. It is normally undertaken in a dimly lit room with participants pedalling together on individual stationary bikes, led by a trained instructor (Caria et al., 2007). Fast-paced music is used to help control the pace and intensity of the exercise session. Various positions on the cycles are used during the classes, including cycling while standing, alternating between standing and sitting, and cycling at a very fast pace. The spin bikes are designed differently to normal stationary cycles in that they contain a 20-kg flywheel which allows for manual resistance control or for constant resistance (Hernendez, 2001). The control in the resistance of the cycle allows the user to stand or sit on the cycle without the pedals losing the resistance, which aids in the stability of the user during cycling. Cycling exercise has an advantage over other exercising methods such as running as it creates less impact on the joints (Caria et al., 2007). The RPM classes are suggested to improve heart and lung fitness, increase strength and endurance (LesMills website). A single session was used to measure the energy expenditure, power output and heart rate in trained RPM instructors (Caria et al., 2007). During each session, males expended 2482 kJ of energy and produced a mean power output of 120 W, while females expended 1839 kJ of energy and produced a mean power output of 73 W. The participants were found to be working intermittently, at 85 - 88% of their heart rate maximum.

Several studies have shown that group fitness classes are beneficial in improving self-esteem and overall mood (William & Lord, 1997; Wilcox et al., 2006; Barton et al., 2012). Barton et al. (2012)

compared three different exercise regimes – group walking, individual swimming, and social activities (quizzes and bingo) – on reported self-esteem and overall mood during a 6-week intervention. The swimming and walking groups showed a significant improvement in both self-esteem and overall mood, while the social activity group did not. In addition, significantly higher improvement was seen in the group-walking participants than the individual-swimming participants. This was also reflected in the highest attendance rate achieved in the group walking participants compared to the other two regimes. Contrary to these findings, attendance rates between group and individual exercisers in Naumann et al., (2012) did not show any differences. However, the compliance rate of the group exercisers was lower, which may have been due to inconvenient session times (Naumann et al., 2012). Nevertheless, these group exercise sessions can be advantageous as social support within these sessions have been shown to improve participation (Williams & Lord, 1997).

2.6.2 Recreational exercisers and well-trained/elite athletes

The majority of exercise studies examining the effects of carbohydrate ingestion on performance and mood have been conducted on elite or trained athletes (El-Sayed et al., 1997; Backhouse et al., 2005; Hulston & Jeukendrup, 2009). Therefore, studies conducted on recreational exercisers are lacking. Several physiological differences exist between elite athletes and recreational exercisers (Maughan et al., 1983). Recreational exercisers that participate in regular, noncompetitive type of aerobic exercise for 3-5 times per week had lower $\dot{V}O_2max$ and higher fat composition when compared to endurance trained athletes that participated in competition-based intense aerobic exercise training 5 or more times per week (Ziogas et al., 1997). Furthermore, differences in post-prandial triglyceride concentrations were observed between the two groups (Ziogas et al., 1997).

Therefore, recommendations based on the findings by studies on elite athletes cannot be used for recreational exercisers. With the advantages of group fitness classes, intervention studies based on regular exercising population could target the recreational exercisers attending group fitness classes.

2.7 Summary

Physical and mental health play a key role in the health of an individual, and exercise has been shown to have beneficial effects on both. Carbohydrate is an important source of energy during exercise and is a well-known ergogenic aid. The mechanism of action is thought to be via sparing of muscle glycogen. In addition to physiological and performance effects, carbohydrate intake is also known to have effects on mental states, perception and mood. The majority of the studies examining the effects of carbohydrate ingestion have been conducted in single bouts of exercise on trained/elite athletes; whereas studies examining the effects of regular use of carbohydrate ingestion during exercise are lacking. If the benefits of carbohydrates go beyond the improvements in performance, it may also be beneficial to recreational exercisers. Physical and physiological characteristics between elite and recreational exercisers are different and few studies have examined the effects of carbohydrate in recreational exercisers. Future studies need to be conducted to examine the effect of regular carbohydrate ingestion in physiological changes as well as perceptual and mood changes in recreational exercisers.

3.0 Methods

3.1 Participants

Two groups were recruited separately for this study. Recruitment for the Exercise cohort (EXE) was done via advertising through the All Season's Fitness Centre (Howick, Auckland) as the participants were required to attend two cycling exercise ("RPM"/spin) classes per week. Prior to the start of each class, potential participants were approached and given the information sheet (Appendix 1). Posters advertising the trial were also displayed around the centre (Appendix 2). Twelve recreational exercisers (age, 43 ± 12 years; height, 159 ± 40 cm; body mass, 71 ± 13 kg; body fat, 27 ± 8 %; $\dot{V}O_2$max, 43 ± 8 mL/kg/min) volunteered to participate in this study. Participants in the EXE cohort were randomly allocated into Carbohydrate (CHO; n = 6; 5 female, 1 male) and Placebo (PLA; n = 6; 4 female, 1 male) groups.

The Control group (CON) was recruited by word of mouth and through advertisement (Appendix 3 and 4) around the Massey University campus (Albany). Posters and information sheets (Appendix 5) were displayed and distributed in the nearby shopping mall, focusing around supermarkets. Five participants (4 female, 1 male; age, 41 ± 6 years; height, 165 ± 5 cm; body mass, 78 ± 10 kg; body fat, 34 ± 5 %; $\dot{V}O_2$max, 28 ± 4 mL/kg/min) volunteered to participate in the CON group for this study.

The potential participants were asked to complete screening questionnaires (Appendix 6 and 7) prior to their participation. The exclusion criteria included any disabilities or barriers to exercise, hypercholesterolemia, any blood-borne infectious disease, diabetes and/or respiratory problems. All participants were informed verbally and in writing of the nature of the study before signing the consent form (Appendix 8). The study received ethical approval by the Massey University Ethics Committee (*HEC: Southern A, Application 12/06*; Appendix 9).

3.2 Overall design

The overall design of the study is shown in Figure 3.1. The study consisted of a 10-week intervention, with testing sessions pre- and post-intervention for anthropometric, cardiorespiratory fitness, blood sampling and quality of life measures.

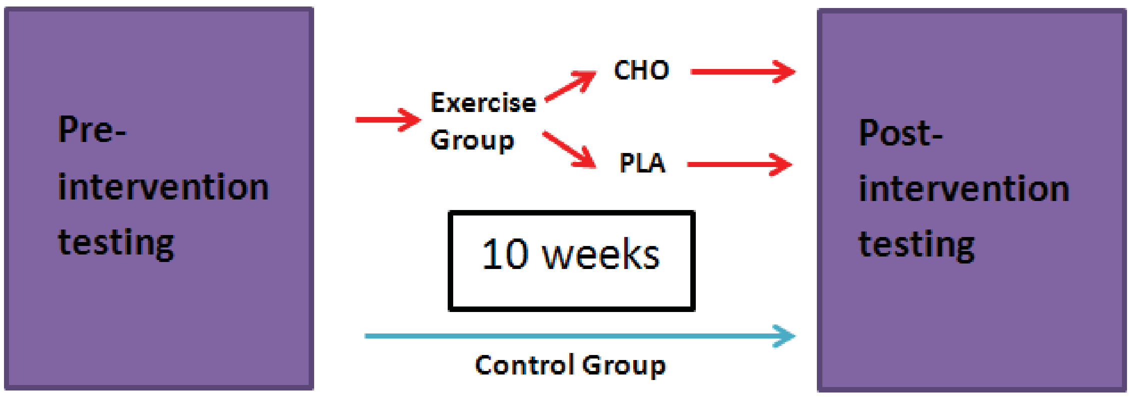


Figure 3.1 Overall design of the study (CHO = carbohydrate group, PLA = placebo group).

During the 10-week intervention period, the EXE group attended two 45-minute spin classes per week. Before each class, the participants were given the drinks according to their groups (PLA or CHO), and were instructed to completely consume the drink whilst exercising. Chest straps were also provided to record their heart rate throughout the exercise session. The participants were given a Training and Monitoring Log (Appendix 10) to complete throughout the week. A new log was provided by the investigator at the beginning of each week as the prior week's log book was collected.

3.3 Pre-intervention testing

The participants were asked to come in for a pre-intervention testing which consisted of anthropometric, cardiorespiratory fitness, blood sampling and quality of life measures. Participants completed the health screening questionnaire (Appendix 11) and signed a consent form prior to commencement of testing. The planned testing schedule and any issues were also discussed prior to testing. The testing session lasted approximately one hour and consisted of a series of procedures (Figure 3.2).

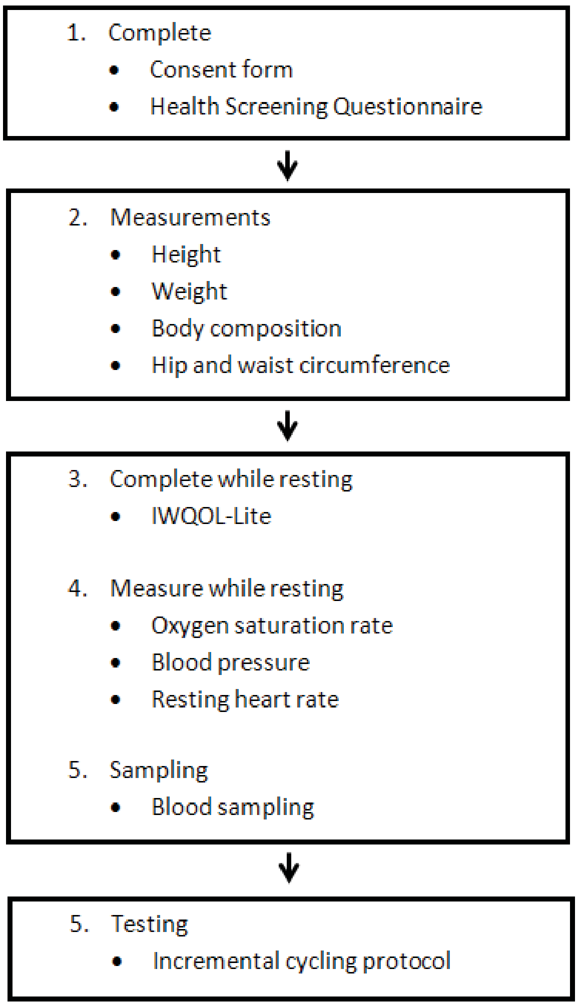


Figure 3.2 Testing day schedule (IWQOL-Lite; Impact of Weight on Quality of Life).

After the testing schedule was explained, the participant's height, body mass, fat composition, and hip and waist circumference were measured (Section 3.3.1 and 3.3.2). This was followed by completion of the Impact of Weight on Quality of Life (IWQOL-Lite; Section 3.3.3) questionnaire while resting. Once rested, the participant's resting heart rate (Section 3.3.4), oxygen saturation rate (Section 3.3.5) and blood pressure (Section 3.3.6) were measured. Lastly, the participants performed an incremental cycling protocol (Section 3.3.7) until volitional fatigue.

3.3.1 Measurement of height, body mass and fat composition.

Height was measured using a wall-mounted stadiometer (Harpenden, United Kingdom) while the participants were standing with their feet together and touching the back board. The measurements were taken while they were in an upright position, with their spines stretched through normal inspiration. The measurements were taken with 0.1 cm accuracy. Body mass and fat compositions were measured using air displacement plethysmography, and the accompanying scale (INC BODPod Gold Standard – Body Composition Tracking System, CosMED Rome, Italy; BodPod). The BodPod required a 3-hour warm up period which was performed prior to the commencement of each testing session. This process involved five stages including warm-up, hardware check, scale calibration, scale check and volume check. Prior to entering the BodPod for the required measures, the participants were asked to remove any jewellery, and change into tight-fitting swimming togs, boxers or bike pants (without padding) and/or sports bra (without padding or wires) that were appropriate for the air displacement plethysmography (INC BODPod Gold Standard – Body Composition Tracking System, CosMED Rome, Italy; BodPod) measurements and to void if necessary.

3.3.2 Hip and waist circumference

Hip and waist circumference were assessed using a measuring tape (KDS diameter ruler, F10-02DM) to the nearest millimetre. Waist circumference was measured at the point midway between the inferior margin of the lowest rib and the crest of the ilium at normal expiration. Hip circumference was measured at the level of the buttock's greatest posterior protuberance, perpendicular to body trunk while relaxed and feet placed together. Waist-to-hip ratio and BMI were calculated using the following equations:

$$\text{Waist to hip ratio} = \text{waist circumference (cm)}/\text{hip circumference (cm)}$$

$$\text{BMI} = \text{weight (kg)}/\text{height (m)}^2$$

3.3.3 Impact of Weight on Quality of Life (IWQOL-Lite)

The IWQOL-Lite (Duke University, 1995) is the condensed form of the IWQOL questionnaire developed by clinicians at Duke University's Diet and Fitness Centre (Kolotkin, 2001; Appendix 12). This questionnaire examines the effects of the obese condition on quality of life. The questionnaire consists of 31 items, sub-divided into 5 subscales: 11 items relating to physical function, 7 for self-esteem, 4 to sexual life, 5 to public distress and 4 to their daily activities such as work. Each question was answered by choosing from a scale ranging from 1 (never true) to 5 (always true). The questionnaire provides a score for each of the 5 sub-scales.

3.3.4 Blood pressure

Blood pressure was manually measured using a sphygmomanometer (ALPK2, Tokyo, Japan) and a stethoscope (PHY-302, Ambala, India). The sphygmomanometer was placed on the right arm, around the distal region of the biceps brachii, while the stethoscope was placed over the artery in the antecubital space. Pressure was raised up to approximately 140mmHg and released slowly. The pressure at which the first 'Korotkoff' sound was heard was recorded as the systolic pressure, whilst the point at which the sounds diminished was recorded as the diastolic pressure. Two readings were measured accurate to the nearest ± 2 mmHg.

3.3.5 Oxygen saturation rate

Oxygen saturation rate was measured using a pulse oximeter (SB100, Rossmax InnoTek Corp, Taiwan) using the second index finger of the left hand. The hand was positioned with the palms facing upwards and resting lightly on a desk.

3.3.6 Blood sampling

Blood samples (~10 mL per sample) were taken by venipuncture (Insyte, Becton Dickson, NJ, USA) into a medial antecubital vein. Blood samples were collected after measuring the participant's resting blood pressure and left at ambient temperature for 30-60 minutes then centrifuged for 10 minutes at 3500 RPM (MF 50, Hanil Science Industrial Co., Korea). A duplicate of EDTA and Li Heparin tube of each sample (5 mL) was taken and stored as plasma (at -80 °C) until later analysis of glucose, cholesterol, high-density lipoprotein (HDL-C) and triglycerides. The sample was divided into 16 aliquots (350µL per aliquot) – 4 aliquots per metabolite. The glucose concentration was analysed by the hexokinase method (Roche Cobas MIRA; Flexor E, Vitalab Scientific N.V; 6956 AV Spankeren/Dieren, The Netherlands; Peterson & Young, 1958), total cholesterol concentration by cholesterol esterase/cholesteroloxisaes/peroxidase method (Roche Cobas MIRA; 6956 AV Spankeren/Dieren, The Netherlands; Flexor E, Vitalab Scientific N.V; Allain et al., 1974), HDL-C concentration by detergent/cholesterol esterase/cholesteroloxisase/peroxidase method (Roche Cobas MIRA; Flexor E, Vitalab Scientific N.V; 6956 AV Spankeren/Dieren, The Netherlands; Allain et al., 1974) and triglyceride by lipase/glycerol kinase method (Roche Cobas MIRA; Flexor E, Vitalab Scientific N.V; 6956 AV Spankeren/Dieren, The Netherlands; Wahlefeld & Bergmeyer, 1831). The low-density lipoprotein (LDL-C) was calculated by subtracting the HDL-C concentration by the total cholesterol concentration (Friedewald et al., 1972). These analyses were carried out by the Nutrition Laboratory, Massey University.

3.3.7 Cardiorespiratory fitness testing protocol

To assess cardiorespiratory fitness, an incremental cycling protocol was used. This required the participant to cycle at 60 rev/min continuously until volitional fatigue on a cycle ergometer (Ergomedic 874E, Monark, Sweden). The power output was adjusted by increasing the load by 0.5 kg after each 3-minute stage. During the last minute of each 3-minute stage, expired air, heart rate and ratings of perceived exertion (RPE) were collected (Figure 3.3). Verbal encouragement was given throughout the protocol.

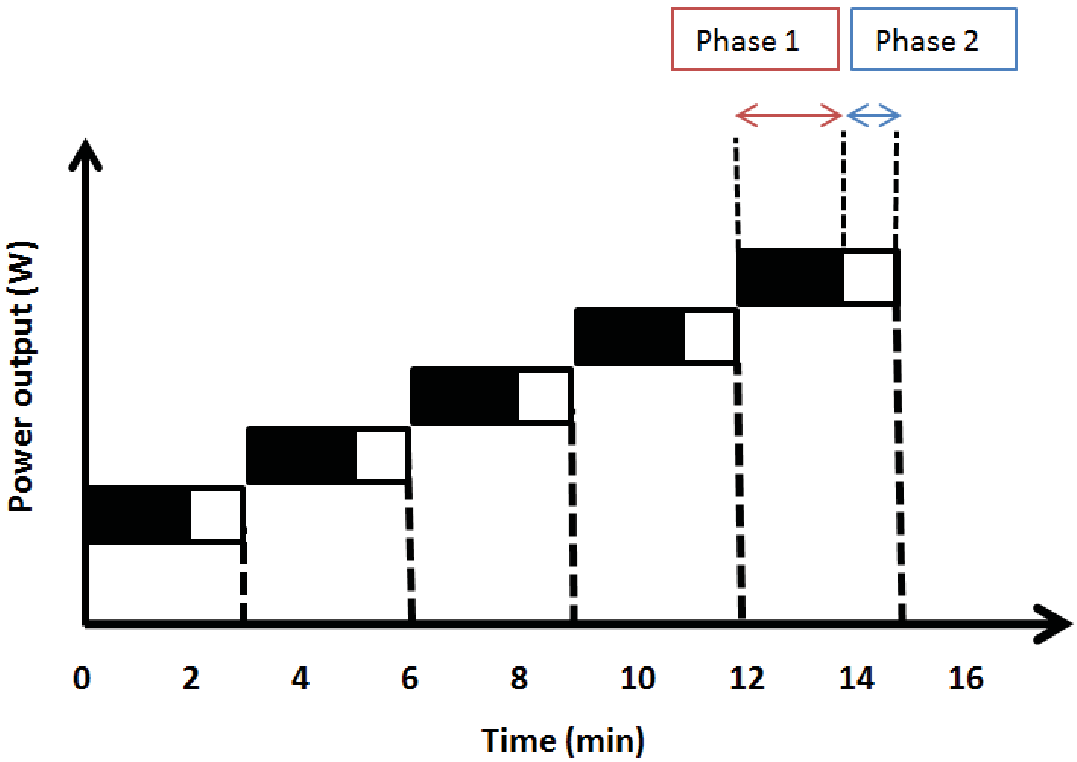


Figure 3.3 Progressive increase in power output during the incremental cycling protocol. During each 3-minute stage, continuous exercise was performed at 60 rev/min during both phase 1 and 2. The heart rate and ratings of perceived exertion (RPE) measures, as well as expired air were collected during phase 2 whilst continuously cycling.

Expired air was collected using the Douglas bag technique (Douglas, 1911), where the participants breathed into the Douglas bags connected to the mouthpiece via a low resistance two-way valve and an airway tube. The mouthpiece and a nose clip were presented 30 seconds prior to the collection to prepare and evacuate the 'dead space' created by the connecting apparatus between the mouthpiece and the Douglas bag. The nose clip was utilised for complete collection of the expired air. The samples in the Douglas bags were later analysed for oxygen (O_2) and carbon dioxide (CO_2) concentrations using a O_2 and CO_2 analyser (Servomex 1440 Gas Analyser, Crowborough, England), as well as the volume (Harvard Appartus, Edenbridge, England), to determine further respiratory variables.

3.3.8 Maximal oxygen uptake ($\dot{V}O_2max$)

$\dot{V}O_2max$ was estimated by analysing expired air collected during the final stage of the incremental cycling protocol. Participants were asked to give a signal when they could only continue for a further minute, but could not finish the 3-minute stage. When the signal was acknowledged, the expired air was collected and analysed. Therefore, the final stage was determined at the participant's volitional fatigue.

3.3.9 Ambient temperature and barometric pressure

Ambient temperature and barometric pressure were recorded on testing days using an onsite weather station (Deluxe Weather Station 2111, Dick Smith Electronics, Auckland, New Zealand).

3.4 Intervention

3.4.1 Heart rate measures

Heart rate measurements were conducted using a chest strap and a short range telemetric downloadable monitor (Polar Electro S6101, Kempele, Finland). After ensuring the conductance area of the chest strap was moist for proper conductance, the chest strap was fitted around the participant's chest. Heart rate data recorded during the exercise sessions were downloaded onto a computer using appropriate software (Polar ProTrainer 5 version 5.40.172, Kempele, Finland).

The recorded heart rates were allocated into separate zones. The zones were set according to Halson et al. (2004) based on calculated heart rate maximum (HRmax) by the commonly used '220-age' equation (Robinson, 1938).

Zone 1: <69% HRmax

Zone 2: 69-81% HRmax

Zone 3: 82-87% HRmax

Zone 4: >88% HRmax

3.4.2 Log book

The participants in the EXE cohort completed a Training and Monitoring Log on the day of each exercise session (Appendix 10) throughout the 10-week intervention. The participants' perceived working resistance, ratings of perceived exertion (RPE), ratings for the Feeling Scale (FS) and Felt Arousal Scale (FAS) of each exercise sessions were recorded.

3.4.2.1 Perceived working resistance

The resistance of the spin bike used during exercise are self-adjusted. Therefore, the perceived working resistance of each exercise session was recorded. The 3-point scale ranged from 1 (low) to 3 (high; Appendix 10).

3.4.2.2 Ratings of Perceived Exertion (RPE)

The RPE scale (Borg, 1973; Appendix 13) is a measure of the degree of physical exertion experienced by the participant. It is a 15-point scale ranging from 6 (very, very light) to 20 (very, very hard).

3.4.2.3 Feeling Scale (FS)

The FS measures pleasure-displeasure feelings during exercise (Hardy and Rejeski, 1989; Appendix 14). It is an 11-point scale ranging from +5 (very good) to -5 (very bad).

3.4.2.4 Felt Arousal Scale (FAS)

The FAS measures how 'worked up' or aroused individuals feel during the exercise session. The scale ranges from 1 (low arousal) to 6 (high arousal) (Svebak and Murgatroyd, 1985; Appendix 15). Low arousal is characterised by the feeling of relaxation, boredom and/or calmness while high arousal is characterised by anxiety and/or anger.

3.4.3 Beverage formulation and consumption

The beverages were only provided to participants in the EXE group during each exercise session throughout the intervention. The drinks were formulated using a previously established method described by Ali et al. (2011) (Table 3.1). The carbohydrate drinks contained 7.5% carbohydrate and placebo solutions contained 0% carbohydrate. Both drinks were taste and colour matched and provided in a clear water bottle, labelled with the participant's name. Drinks were manufactured every two weeks and each participant received 5 mL/kg BM of fluid prior to each exercise session.

The drinks were provided approximately 5-10 minutes before each exercise session for complete consumption during the 45 minute class. The sipper bottle was collected at the end of each exercise session to check that the participants had consumed all of the test solutions. Although water consumption was not restricted during the exercise session other fluids were not consumed by any of the participants during the exercise sessions.

Table 3.1 Composition of the carbohydrate and placebo drinks produced for the two groups.

	Sucrose (g/L)	Maltodextrin (g/L)	Aspartame (g/L)	Citric Acid (g/L)	Sodium Chloride (g/L)
Placebo (PLA)	0	0	0.42	0.19	0
Carbohydrate (CHO)	59	16	0	0.19	1.067

3.5 Post-intervention testing

After the completion of the 10-week intervention, the participants were asked to come in for a post-intervention testing that consisted of the same testing schedule outlined in Section 3.3.

3.5.1 Post-intervention questionnaire

This questionnaire was completed by the EXE group only after the completion of the post-intervention testing (Appendix 16). The questionnaire was completed on-line for convenience. The questionnaire consisted of 5 items: normal dietary intake prior to the exercise sessions, their regular CHO drink intake, estimation of participant allocation to the two groups (CHO vs. PLA), the frequency and load of the drinks taken during the exercise session, and any general comments about the drink.

3.6 Statistical analysis

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS, Chicago, IL, version 20). Independent Student's *t*-test was used to examine the baseline and metabolic measures between the two groups in the EXE cohort (i.e. CHO vs. PLA) and between EXE and CON. The effect of the intervention was examined by calculating the difference between pre- and post-intervention which was also analysed by independent Student's *t*-test. In addition, one-way and two-way (treatment x time) ANOVA of repeated measures were used to test the treatment, time, and interaction effects in the variables measured throughout the intervention between CHO and PLA. Post-hoc testing using independent *t*-test with stepwise Holm-Bonferroni methods was used to determine where the differences lay. Sphericity was examined by Mauchly's test for sphericity, and if violated the Huynh-Feldt correction was applied. Chi-square test was conducted to examine the post-intervention questionnaire. Pearson's correlations were used to examine any relationships between the variables measured. An r value of < 0.49 represents a weak correlation, 0.5 - 0.79 a moderate correlation, and ≥ 0.8 represented a strong correlation (Morton et al, 1996). Data are presented as means ± standard deviations. The level of significance was accepted at $p < 0.05$.

4.0 Results

The results section will be divided into two parts. It will begin by exploring the results of carbohydrate (CHO) and placebo (PLA) groups to address the first aim which was to examine the effect of carbohydrate ingestion during a 10-week exercise regime on health and fitness parameters, mood and quality of life in recreational exercisers. This will lead onto exploring the results of the exercise cohort (EXE) and control (CON) group to address the secondary aim of examining the effect of 10 weeks of cycling exercise ('spin' classes) on health and fitness parameters.

4.1 Results of CHO and PLA groups

4.1.1 Anthropometric measures

The anthropometric characteristics of the CHO and PLA groups are shown in Table 4.1. Gender distributions were similar between the two groups (1 male and 5 female, CHO; 2 male and 4 female, PLA). There was no significant difference in the change from pre- to post-intervention in body mass ($t(10) = 0.77$, $p = 0.46$), fat composition ($t(10) = -0.61$, $p = 0.56$), waist-to-hip ratio ($t(10) = 1.29$, $p = 0.26$), BMI ($t(10) = 0.85$, $p = 0.42$), resting heart rate ($t(10) = 0.86$, $p = 0.39$), oxygen saturation rate ($t(10) = 0.80$, $p = 0.46$), resting systolic blood pressure ($t(10) = -0.31$, $p = 0.76$) and $\dot{V}O_2max$ ($t(10) = -1.10$, $p = 0.75$) between CHO and PLA groups. However the change in resting diastolic pressure was significant ($t(10) = -2.83$, $p = 0.01$) where CHO group showed a decrease from 78.0 ± 8.3 mmHg to 72.7 ± 5.3 mmHg while the PLA showed an increase from 77.0 ± 7.9 mmHg to 80.0 ± 8.2 mmHg.

There were no significant differences in the pre-intervention measures in any of the aforementioned variables between CHO and PLA groups ($p > 0.05$).

Table 4.1 Pre- and post-intervention measures, and the changes throughout the 10-week intervention, of anthropometry and physiological measures in the carbohydrate (CHO) and placebo (PLA) groups. * significantly different between CHO and PLA groups ($p < 0.05$).

	CHO (n = 6)			PLA (n = 6)		
Age (years)	46.2 ± 10.2			45.8 ± 8.3		
Height (cm)	167.1 ± 8.1			171.9 ± 5.9		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Body mass (kg)	70.2 ± 16.4	70.3 ± 16.8	+0.1 ± 0.9	71.3 ± 9.6	71.9 ± 8.8	+0.6 ± 1.6
Fat composition (%)	27.5 ± 7.9	26.6 ± 5.9	-0.9 ± 3.7	25.9 ± 9.4	24.0 ± 10.0	-1.9 ± 1.8
Waist-to-hip ratio	0.84 ± 0.11	0.82 ± 0.10	-0.02 ± 0.02	0.81 ± 0.13	0.81 ± 0.12	-0.01 ± 0.02
BMI (kg/m^2)	24.8 ± 3.6	24.8 ± 3.7	+0.0 ± 0.3	24.1 ± 2.7	24.3 ± 2.4	+0.2 ± 0.5
HRrest (beats/min)	61.2 ± 6.0	62.7 ± 9.2	+1.5 ± 8.3	62.3 ± 9.1	60.4 ± 8.2	-1.9 ± 3.6
SaO_2 (%)	98.5 ± 0.5	98.0 ± 0.9	-0.5 ± 1.2	96.7 ± 3.4	98.0 ± 1.2	+0.7 ± 3.4
Systolic BP rest (mmHg)	122.0 ± 10.7	118.0 ± 9.4	-4.0 ± 10.6	125.3 ± 11.3	122.8 ± 10.3	-2.5 ± 5.2
Diastolic BP rest (mmHg)	78.0 ± 8.3	72.7 ± 5.3	-5.3 ± 4.1*	77.0 ± 7.9	80.0 ± 8.2	+3.0 ± 5.9
$\dot{V}O_2max$ (mL/kg/min)	39.6 ± 6.1	41.2 ± 9.6	+1.6 ± 9.3	44.8 ± 9.7	45.0 ± 9.7	+0.2 ± 3.6

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention; HRrest = resting heart rate; SaO_2 = oxygen saturation rate; Systolic BP rest = Resting systolic blood pressure; Diastolic BP rest = Resting diastolic blood pressure.

4.1.2 Intervention

The number of exercise sessions attended by the participants in CHO and PLA groups throughout the 10-week intervention period was not different (17 ± 3 and 16 ± 3; $t(10) = 0.38$, $p = 0.71$). However, only the first 15 sessions were used to analyse the data as more than 80% of participants attended these sessions.

4.1.2.1 Heart rate

Mean heart rate was consistent throughout the intervention (139.5 ± 10.0 beats/min; $F(14, 42) = 0.96$, $p = 0.51$) and between CHO and PLA groups (140.5 ± 2.5 vs. 138.5 ± 2.7 beats/min; $F(1, 3) = 0.62$, $p = 0.49$). Furthermore, no significant interaction effects of treatment x time were observed between CHO and PLA groups in the mean heart rate throughout the 15 sessions ($F(14, 42) = 0.76$, $p = 0.70$; Figure 4.1).

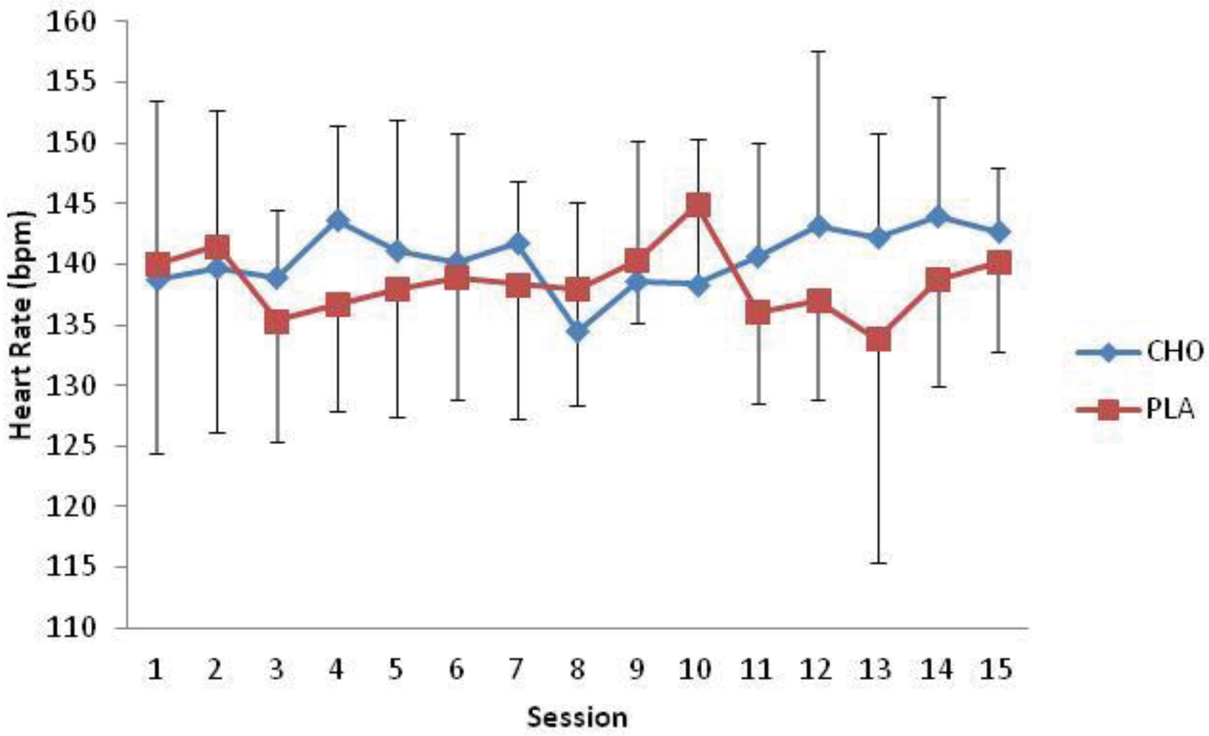


Figure 4.1 The mean heart rate throughout the intervention in CHO and PLA groups (CHO = carbohydrate group; PLA = placebo group).

There was no significant difference between the two groups in any of the heart rate zones (Zone 1, $F(1, 10) = 0.88$, $p = 0.37$; zone 2, $F(1, 10) = 0.15$, $p = 0.71$; zone 3, $F(1, 10) = 0.81$, $p = 0.39$; zone 4, $F(1, 10) = 0.07$, $p = 0.80$). However, the proportion of time spent in zone 1 (21.7 ± 2.3%) was significantly lower than zone 2 (32.8 ± 2.8%) and zone 3 (34.8 ± 2.5%), whereas zone 3 (34.8 ± 2.5%) was higher than zone 4 (10.7 ± 2.6%; $F(3, 15) = 14.7$, $p < 0.01$; Figure 4.2). There was no interaction effect of treatment x time ($F(3, 15) = 0.31$, $p = 0.82$).

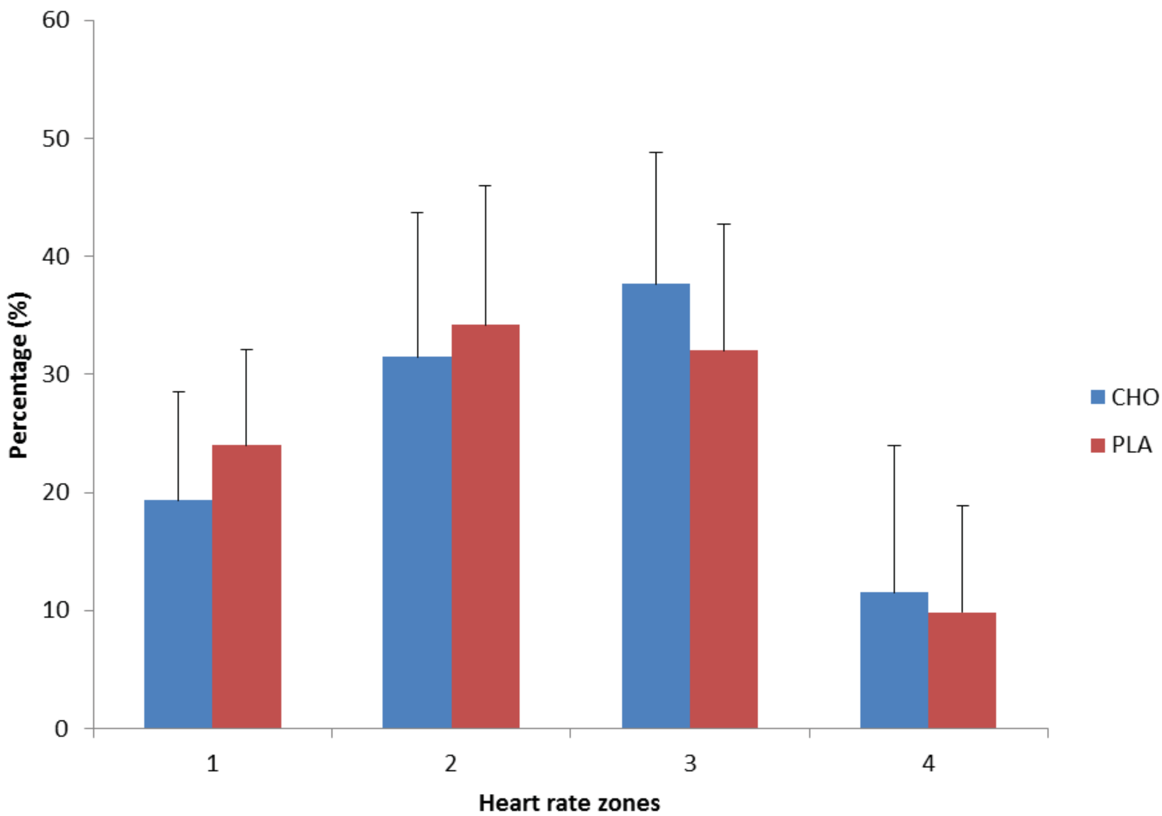


Figure 4.2 Percentage of time spent in different heart rate zones recorded during the exercise sessions in the CHO and PLA groups (CHO = carbohydrate group, PLA = placebo group; Zone 1 = <69% HRmax, zone 2 = 69-81% HRmax, zone 3 = 82-87% HRmax, zone 4 > 88% HRmax).

4.1.2.2 Perceived working resistance

The perceived working resistance was consistent throughout the intervention (2.3 ± 0.5, $F(14, 70) = 1.09$, $p = 0.38$) and between CHO and PLA groups (2.3 ± 0.6 vs. 2.2 ± 0.4; $F(1, 5) = 1.27$, $p = 0.83$). Furthermore, no significant interaction effects of treatment x time were observed between CHO and PLA groups in the perceived working resistance throughout the 15 sessions ($F(14, 70) = 0.63$, $p = 0.83$, Figure 4.3).

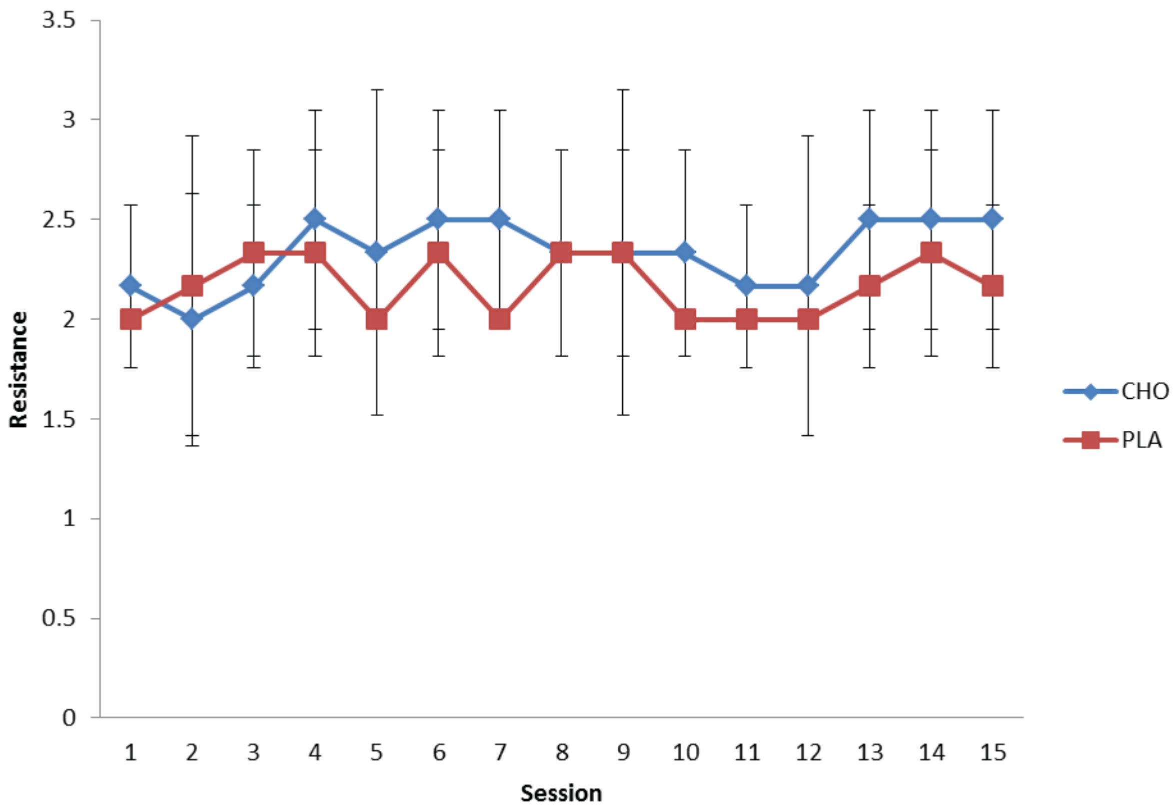


Figure 4.3 The mean perceived working resistance throughout the intervention in CHO and PLA groups (CHO = carbohydrate group; PLA = placebo group).

4.1.2.3 Ratings of Perceived Exertion (RPE)

Session RPE remained consistent throughout the intervention period (14. 9 ± 1.7; $F(14, 70)$ =1.67, p = 0.08). There was no difference in RPE between CHO and PLA (15.1 ± 1.7 vs. 14.6 ± 1.7; $F(1, 5) = 0.65$, $p = 0.46$). Furthermore, interaction effects of treatment x time were observed between CHO and PLA groups in RPE throughout the 15 sessions although non-significant ($F(14, 70) = 1.83$, $p = 0.05$; Figure 4.4).

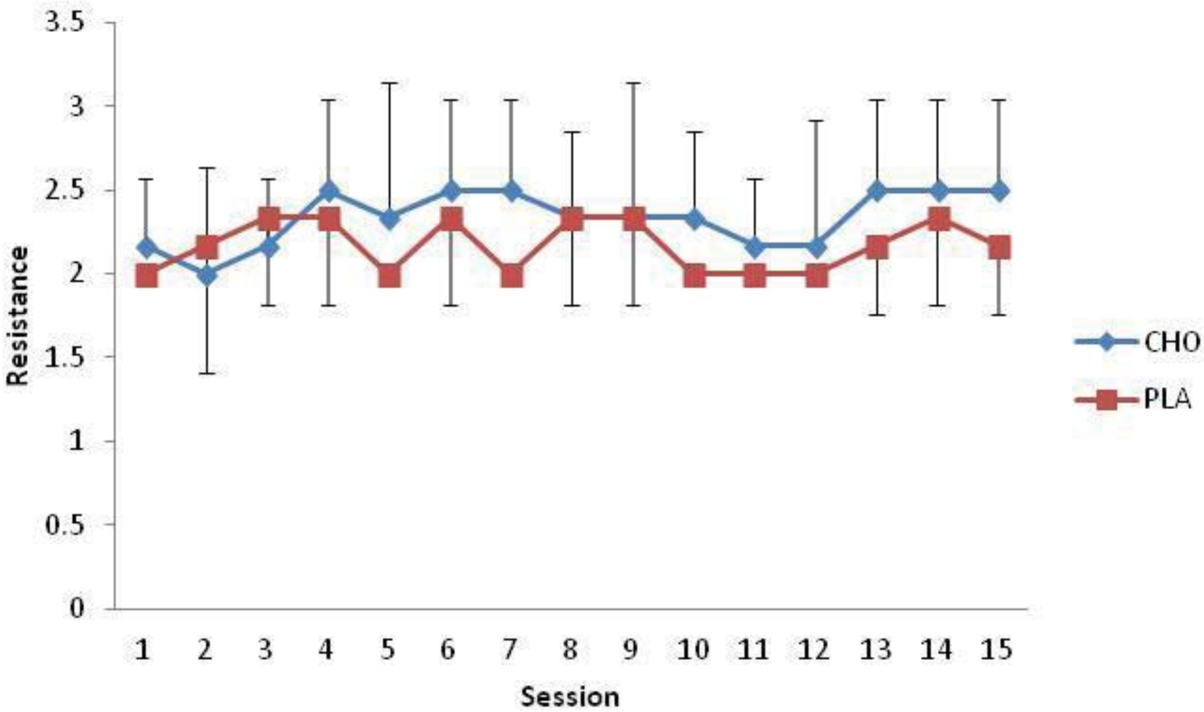


Figure 4.4 The mean Ratings of Perceived Exertion (RPE) throughout the intervention in CHO and PLA groups (CHO = carbohydrate group; PLA= placebo group).

4.1.2.4 Feeling Scale (FS)

The mean FS ratings of the CHO group were higher at all points throughout the 15 sessions (CHO = 3.7 ± 0.9; PLA = 2.9 ± 1.3) however the mean data was not significantly different ($F(1, 5) = 1.47$, $p = 0.28$). Furthermore, FS ratings were consistent throughout the intervention (3.3 ± 1.2; $F(14, 70) = 1.31$, $p = 0.22$) and no significant interaction effects of treatment x time were observed ($F(14, 70) = 0.61$, $p = 0.84$; Figure 4.5).

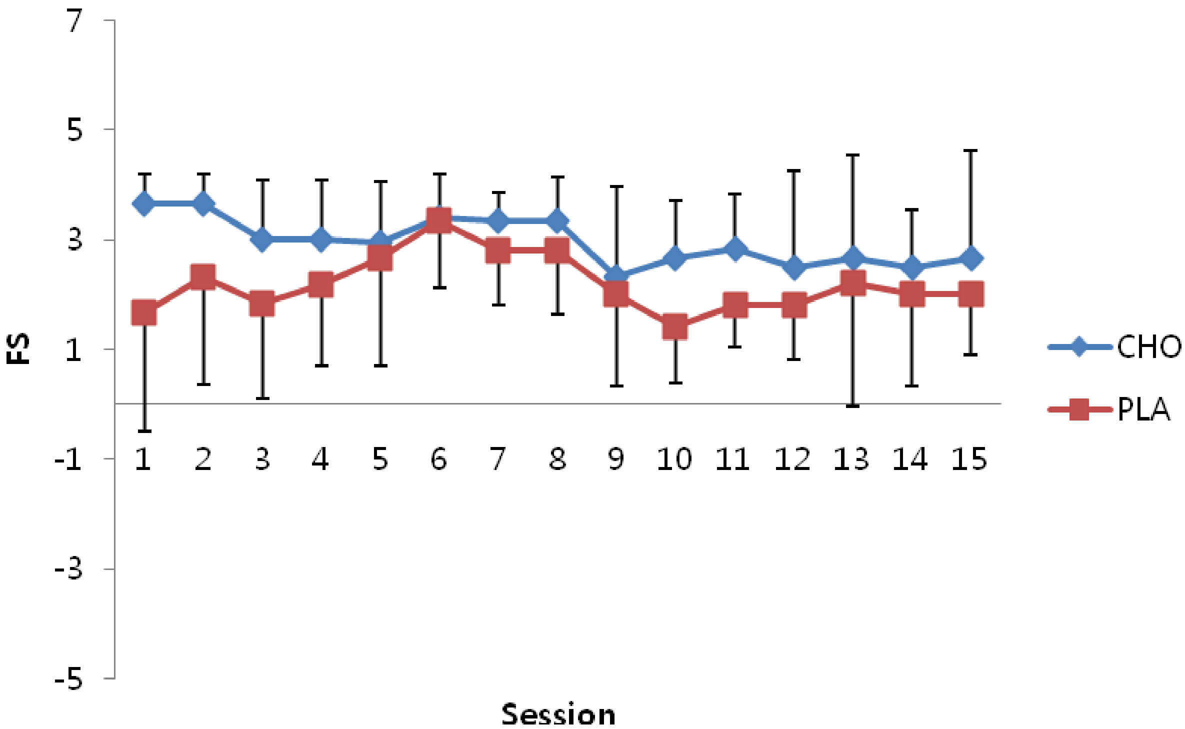


Figure 4.5 The mean ratings of the Feeling Scale throughout the intervention in CHO and PLA groups (CHO = carbohydrate group; PLA = placebo group).

4.1.2.5 Felt Arousal Scale (FAS)

There was a significant time effect for FAS ratings ($F(14, 70) = 2.16$, $p = 0.02$; Figure 4.6) throughout the 15 sessions, however no significant treatment effects between CHO and PLA groups were observed ($F(1, 5) = 2.94$, $p = 0.15$). However, there was a significant interaction effect with an increase in FAS ratings in the CHO group (3.5 ± 0.3 to 4.2 ± 0.3), but a decrease over time in the PLA group (3.5 ± 0.6 to 1.8 ± 0.5; $F(14, 70) = 1.99$, $p = 0.03$). The CHO group was significantly higher at session 10 (3.5 ± 0.5 vs. 2.4 ± 0.8; $t(5) = 3.97$, $p = 0.01$) and session 15 (4.2 ± 0.3 vs. 1.8 ± 0.5; $t(5) = 4.20$, $p < 0.01$).

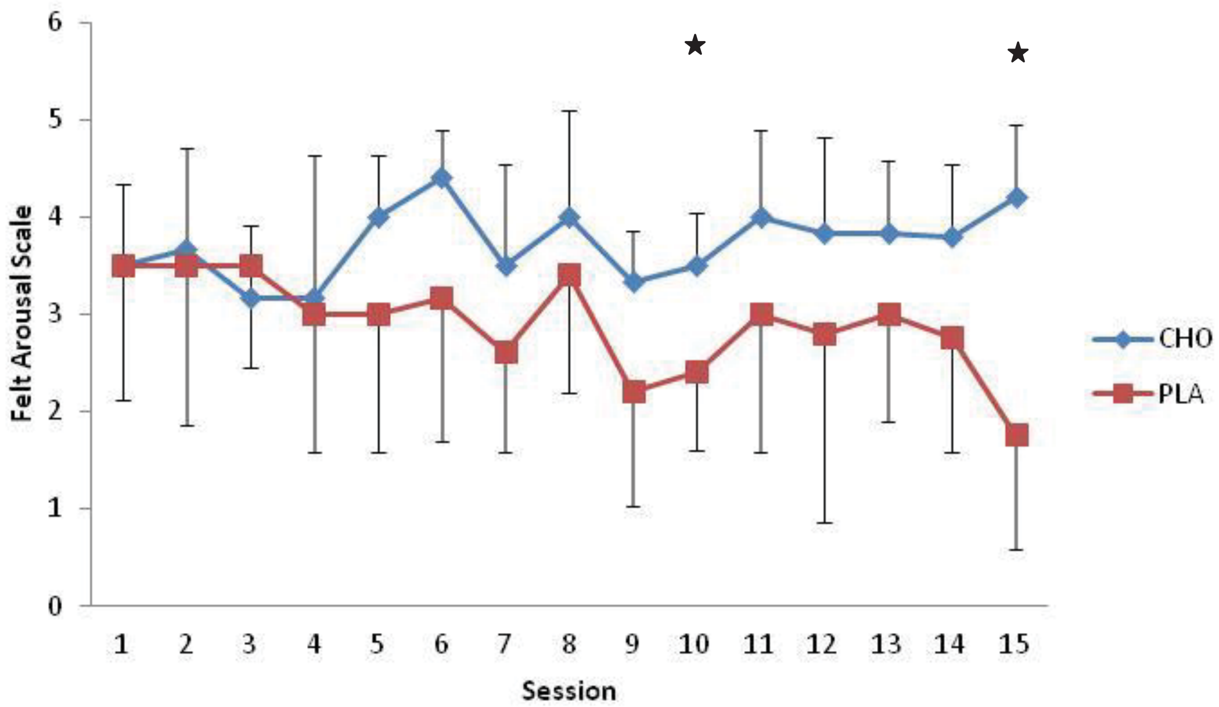
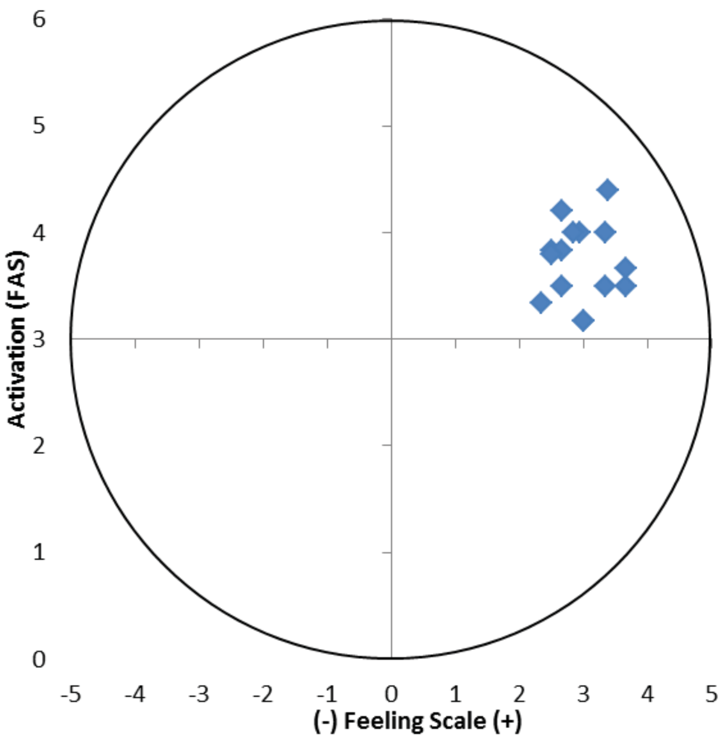


Figure 4.6 The mean ratings of the Felt Arousal Scale throughout the intervention in CHO and PLA groups (CHO = carbohydrate group; PLA = placebo group). ★= significantly different between CHO and PLA groups ($p < 0.05$).

4.1.2.6 Circumplex model

Figure 4.7 depicts a visual plot of the mean FS and FAS ratings during the 15 sessions through a circumplex model (Russell, 1980). Perceived ratings of arousal are represented on the vertical axis with ratings of pleasure-displeasure on the horizontal axis. The model shows participants in the CHO group to be at a higher activation and pleasure scale overall compared to the PLA group. This means that during all sessions, participants in the CHO group were in the 'high-activation, pleasure' quadrant whereas those in the PLA group were in this quadrant for only 60% of the sessions; for the remaining 40% of the sessions, participants in the PLA group were in the 'low-activation, pleasure' quadrant.

A.



B.

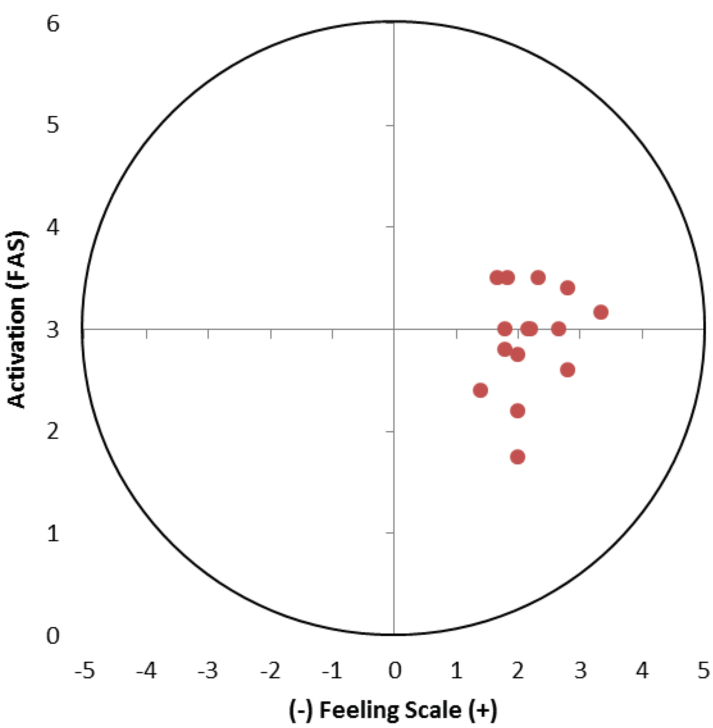


Figure 4.7 Mean Feeling Scale and Felt Arousal Scale values during the 15 sessions shown as Cartesian coordinates in a circumplex model (A = carbohydrate group; B = placebo group).

4.1.3 Metabolic markers

Due to unforeseen circumstances, a total of 10 samples were used for the analyses. Baseline measures of glucose ($t(8) = 1.01$, $p = 0.34$), HDL-C ($t(8) = 1.71$, $p = 0.13$), LDL-C ($t(8) = 0.15$, $p = 0.89$), total cholesterol ($t(8) = 0.55$, $p = 0.60$) and triglyceride ($t(8) = -0.24$, $p = 0.82$) levels were not significantly different between CHO and PLA groups.

HDL-C decreased (-0.08 ± 0.08 mmol/L) in the CHO group from pre to post-intervention while it increased in the PLA group (0.03 ± 0.10 mmol/L; $t(8) = -2.51$, $p = 0.04$). Furthermore, there was a decrease in glucose levels in the CHO group (-0.9 ± 0.7 mmol/L) but an increase in the PLA group (+0.9 ± 0.7 mmol/L; $t(8) = -4.23$, $p < 0.01$; Table 4.2). The LDL-C ($t(8) = -0.45$, $p = 0.67$), total cholesterol ($t(8) = -0.85$, $p = 0.42$) and triglyceride levels ($t(8) = 1.12$, $p = 0.30$) did not change throughout the intervention between CHO and PLA groups.

Table 4.2 Pre- and post-intervention measures, and the changes throughout the 10-week intervention, of high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein (LDL-C), total cholesterol and triglyceride levels in the carbohydrate (CHO) and placebo (PLA) groups. * significantly different between CHO and PLA groups ($p < 0.05$).

	CHO (n = 6)			PLA (n = 6)		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Glucose (mmol/L)	6.2 ± 1.0	5.3 ±0.8	-0.9 ± 0.7*	5.5 ± 1.0	6.5 ± 1.6	+0.9 ± 0.7
HDL-C (mmol/L)	1.13 ± 0.34	1.02 ± 0.36	-0.10 ± 0.06*	0.92 ± 0.14	0.90 ± 0.17	+0.03 ± 0.10
LDL-C (mmol/L)	4.1 ± 1.3	4.2 ± 0.9	+0.1 ± 0.7	3.9 ± 0.9	4.0 ± 1.0	+0.1 ± 0.3
Total cholesterol (mmol/L)	5.2 ± 1.1	5.3 ± 0.6	0.0 ± 0.6	4.8 ± 0.9	4.9 ± 1.1	+0.1 ± 0.3
Triglyceride (mmol/L)	1.1 ± 0.5	1.2 ± 0.3	+0.1 ± 0.2	0.9 ± 0.4	1.0 ± 0.3	+0.1 ± 0.6

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention.

4.1.4 Correlations between variables measured throughout the intervention

An overview of the correlations between the variables measured throughout the intervention is presented in Table 4.3. The CHO group showed positive correlations with perceived working resistance (r = 0.17, p = 0.02), FAS ratings (r = 0.32, p <0.01) and FS ratings (r = 0.27, p <0.01). The FAS rating was also positively correlated with FS rating (r = 0.29, p < 0.01) as well as perceived working resistance (r = 0.25, p <0.01).

Table 4.3 Correlations between the variables measured throughout the intervention. *significant correlation (p < 0.05).

				Correlations				
	Mean	SD	n	Heart rate	Perceived working resistance	RPE	FAS	FS
Perceived working resistance	2.25	0.49	180	0.14				
RPE	14.9	1.7	180	0.10	0.49*			
FAS	3.3	1.2	180	0.09	0.25*	0.21*		
FS	2.6	1.4	180	0.07	0.15	0.10	0.29*	
Treatment	0.50	0.50	180	0.09	0.17*	0.12	0.32*	0.27*

RPE; Ratings of Perceived Exertion, FAS; Felt Arousal Scale, FS; Feeling Scale.

4.1.5 Quality of life

There were no differences in changes pre- and post-intervention in any of the five subscales of the IWQOL-Lite questionnaire (all $p > 0.05$). No significant differences were also observed at baseline in the five subscales (all $p > 0.05$).

Table 4.4 Pre- and post-intervention measures, and the changes throughout the 10-week intervention of the Impact of Weight on Quality of Life in carbohydrate (CHO) and placebo (PLA) groups.

	CHO (n = 6)			PLA (n = 6)		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Physical function	92.5 ± 6.3	94.5 ± 7.8	+2.0 ± 3.9	95.5 ± 5.4	97.3 ± 4.5	+1.8 ± 4.5
Self-esteem	78.0 ± 30.5	83.2 ± 30.6	+5.2 ± 7.4	85.2 ± 17.9	86.3 ± 21.4	+1.2 ± 6.3
Sexual life	91.7 ± 12.9	92.7 ± 18.0	+1.0 ± 14.0	98.0 ± 4.9	95.8 ± 10.2	-2.2 ± 5.3
Public Distress	99.2 ± 2.0	97.5 ± 6.1	-1.7 ± 4.1	100.0 ± 0.0	100.0 ± 0.0	0.0 ± 0.0
Work	99.0 ± 2.4	99.0 ± 2.4	0.0 ± 0.0	100.0 ± 0.0	100 ± 0.0	0.0 ± 0.0
Total	92.1 ± 9.8	93.4 ± 12.9	+1.3 ± 4.2	95.7 ± 5.3	95.9 ± 6.2	+0.2 ± 1.2

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention.

4.1.6 Post-intervention questionnaire

The participants in the CHO and PLA groups completed an on-line post-intervention questionnaire.

Although non-significant, 33.3% of the participants reported they ate prior to exercise, whereas 77.7% of the participants reported they exercised in a fasted state (c^2(1, *n* = 12) = 1.33, *p* =0.25). This was not significantly different between CHO and PLA groups (c^2(1, *n* = 12) = 0.00, *p* = 0.73).

There was no significant difference in the proportion of participants that normally took CHO drinks between CHO and PLA groups (c^2(1,n =12) = 0.00, *p* = 0.77). However significantly higher proportion of participants (83%) did not normally take carbohydrate drinks (c^2(1, n = 12) = 5.33, *p* =0.02).

The method of intake (volume and frequency) was not significantly different between the CHO and PLA groups (c^2(2, n = 12) = 2.48, *p* =0.29). The proportion of participants ingesting 'large volume, less frequently', 'moderate volume, moderate frequency' and 'small volume, frequently' were not significantly different (c^2(2, n = 12) = 3.50, *p* =0.17).

There was no significant difference in the proportion of participants that guessed their allocated group correctly between CHO and PLA groups (c^2(1, n = 12) = 3.09, *p* =0.79). Although non-significant, 41.6% of the participants guessed their assigned groups correctly while 33.3% of the participants did not know and 25.1% of the participants guessed incorrectly (c^2(2, n = 12) = 4.80, *p* =0.10).

4.2 Results of EXE and CON groups

4.2.1 Anthropometric measures

The anthropometric characteristics of the EXE and CON groups are shown in Table 4.5. The two groups had similar gender distributions (EXE 3 male 9 female; CON 1 male, 4 female). There were no differences in the baseline measures of age, height, body mass, fat composition, waist-to-hip ratio, oxygen saturation rate and blood pressure between EXE and CON groups (all $p > 0.05$). At baseline, BMI (24.5 ± 3.0 vs. 28.7 ± 4.1 kg/m^2; $t(15) = -2.34$, $p = 0.03$) and resting heart rate was lower (61.8 ± 7.4 vs. 76.8 ± 7.6 beats/min; $t(15) = -3.79$, $p < 0.01$) in the EXE group. However, $\dot{V}O_2$max was higher in the EXE cohort (42.2 ± 8.2 vs. 28.1 ± 3.6 mL/kg/min; $t(15) = 3.93$, $p < 0.01$) at baseline.

There were no significant differences in the changes from pre- to post-intervention in body mass ($t(15) = -1.05$, $p = 0.39$), fat composition ($t(15) = 1.20$, $p = 0.33$), BMI ($t(15) = -1.03$, $p = 0.42$), resting heart rate ($t(15) = 1.34$, $p = 0.24$), oxygen saturation rate ($t(15) = 0.39$, $p = 0.63$), resting systolic ($t(15) = -0.67$, $p = 0.52$) and diastolic ($t(15) = 0.37$, $p = 0.70$) blood pressure and $\dot{V}O_2$max ($t(15) = -0.16$, $p = 0.75$). However, there was a decrease of waist-to-hip ratio in the EXE cohort (0.01 ± 0.02) but an increase in the CON group (0.03 ± 0.03, $t(15) = 2.73$, $p = 0.02$).

Table 4.5 Pre- and post-intervention measures, and the changes throughout the 10-week intervention, of anthropometric and physiological measures of the exercise (EXE) and control (CON) groups. * significantly different between EXE and CON groups ($p < 0.05$).

	EXE (n = 12)			CON (n = 6)		
Age (years)	46.0 ± 8.9			41.2 ± 5.8		
Height (cm)	169.5 ± 7.2			165.0 ± 4.7		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Body mass (kg)	70.8 ± 12.8	71.1 ± 12.8	+0.5 ± 0.3	77.8 ± 9.5	77.3 ± 8.9	-0.5 ± 1.8
Fat composition (%)	26.7 ± 8.3	25.3 ± 7.9	-1.4 ± 2.8	33.9 ± 5.4	34.5 ± 5.1	+0.6 ± 3.7
Waist-to-hip ratio	0.83 ± 0.12	0.81 ± 0.11	-0.01 ± 0.02*	0.81 ± 0.03	0.84 ± 0.04	+0.03 ± 0.0.3
BMI (kg/m^2)	24.5 ±3.0*	24.5 ± 3.0	+0.1 ± 0.4	28.7 ± 4.1	28.5 ± 4.0	-0.2 ± 0.6
HRrest (beats/min)	61.8 ±7.4*	61.6 ± 8.4	-0.2 ± 6.4	76.8 ± 7.6	70.4 ± 8.4	- 6.4 ± 9.7
SaO_2 (%)	97.6 ± 2.5	98.0 ± 1.0	+0.1 ± 2.5	97.8 ± 1.6	97.4 ± 0.5	-0.4 ± 1.5
Systolic BP rest (mmHg)	124.7 ± 10.6	120.4 ± 9.7	-3.3 ± 8.0	121.2 ± 10.8	120.8 ± 10.0	-0.4 ± 7.9
Diastolic BP rest (mmHg)	77.5 ± 7.7	76.3 ± 7.6	-1.2 ± 6.5	80.8 ± 7.9	78.4 ± 5.2	-2.4 5.5
$\dot{V}O_2$max (mL/kg/min)	42.2 ± 8.2*	43.1 ± 9.4	+1.3 ± 7.0	28.1 ± 3.6	28.8 ± 5.5	+0.6 ± 8.1

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention; HRrest = resting heart rate; SaO_2 = oxygen saturation rate; Systolic BP rest = Resting systolic blood pressure; Diastolic BP rest = Resting diastolic blood pressure.

4.2.2 Metabolic markers

Due to unforeseen circumstances, a total of 15 samples were used for the analyses. There were no differences in the baseline measures of glucose, HDL-C, LDL-C, total cholesterol and triglyceride (all $p > 0.05$).

The change in the concentrations of metabolic markers from pre- to post-intervention was not different for glucose ($t(13) = -1.6$, $p = 0.14$), HDL-C ($t(13) = -0.65$, $p = 0.53$), LDL-C ($t(13) = -0.48$, $p = 0.64$), total cholesterol ($t(13) = -0.59$, $p = 0.56$) and triglyceride ($t(13) = 0.14$, $p = 0.89$) between EXE and CON groups.

Table 4.6 Pre- and post-intervention measures, and the changes throughout the 10-week intervention, of high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C), total cholesterol and triglyceride levels in the exercise (EXE) and control (CON) groups.

	EXE (n = 12)			CON (n = 5)		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Glucose (mmol/L)	5.9 ± 1.0	5.8 ± 1.2	-0.1 ± 1.1	5.1 ± 2.2	6.2 ± 0.7	+1.1 ± 2.1
HDL-C (mmol/L)	1.00 ± 0.2	0.95 ± 0.25	-0.05 ± 0.09	0.78 ± 0.1	0.76 ± 0.1	-0.02 ± 0.04
LDL-C (mmol/L)	4.0 ± 1.0	4.1 ± 1.0	+0.1 ± 0.5	3.0 ± 0.4	3.3 ± 0.4	+0.3 ± 0.7
Total cholesterol (mmol/L)	5.0 ± 1.0	5.0 ± 0.9	+0.1 ± 0.5	3.8 ± 0.4	4.0 ± 0.4	+0.2 ± 0.7
Triglyceride (mmol/L)	1.0 ± 0.4	1.1 ± 0.3	+0.1 ± 0.4	0.8 ± 0.2	0.9 ± 0.1	+0.1 ± 0.3

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention.

4.2.3 Quality of life (QoL)

The 'work' subscale in the EXE group was higher (99.5 ± 1.7) than the CON group (91.2 ± 12.2; $t(15) = 2.40$, $p = 0.03$) at baseline. Physical function ($t(15) = 1.14$, $p = 0.27$), self-esteem ($t(15) = 1.34$, $p = 0.20$), sexual life ($t(15) = 0.54$, $p = 0.60$), public distress ($t(15) = -0.63$, $p = 0.54$) and overall QoL ($t(15) = 1.47$, $p = 0.16$) were not significantly different at baseline.

There were no significant changes from pre- to post-intervention in physical function ($t(15) = -0.04$, $p = 0.97$), self-esteem ($t(15) = 0.08$, $p = 0.94$), sexual life ($t(15) = 0.95$, $p = 0.36$), public distress ($t(15) = 0.63$, $p = 0.54$;) and overall QoL ($t(15) = -1.26$, $p = 0.23$; Table 4.7) between groups. Although non-significant, the 'work' subscale showed a trend for an increase in the CON group (7.6 ± 13.5; $t(15) = -2.04$, $p = 0.06$) while EXE cohort did not change.

Table 4.7 Pre- and post-intervention measures, and the changes throughout the 10-week intervention of the Impact of Weight on Quality of Life in exercise (EXE) and control (CON) groups. * significantly different between EXE and CON groups ($p < 0.05$).

	EXE (n = 12)			CON (n = 5)		
	Pre-	Post-	Δ	Pre-	Post-	Δ
Physical function	94.0 ± 5.8	95.9 ± 6.3	+1.9 ± 4.0	89.6 ± 10.3	91.4 ± 6.7	+1.8 ± 7.8
Self-esteem	81.6 ± 24.1	84.8 ± 25.2	+3.2 ± 6.9	65.0 ± 20.5	68.6 ± 29.7	+3.6 ± 15.1
Sexual life	94.8 ± 9.9	94.3 ± 14.0	-0.6 ± 10.2	91.0 ± 20.1	97.6 ± 3.3	+6.6 ± 21.7
Public Distress	99.6 ± 1.4	98.8 ± 4.3	-0.8 ± 2.9	100.0 ± 0.0	100.0 ± 0.0	0.0 ± 0.0
Work	99.5 ± 1.7*	99.5 ± 1.7	0.0 ± 0.0	91.2 ± 12.2	98.9 ± 2.7	7.6 ± 13.5
Total	93.9 ± 7.8	94.6 ± 9.7	+0.73 ± 3.0	87.4 ± 9.9	91.3 ± 6.5	+3.9 ± 7.7

Pre- = pre-intervention; Post- = post-intervention; Δ = changes from pre- to post-intervention.

5.0 Discussion

The main aim of this study was to examine the effect of carbohydrate ingestion during a 10-week exercise intervention on health and fitness parameters, mood and quality of life in recreational exercisers. Although the results of the current study found no changes in anthropometry, physiological and quality of life measures with carbohydrate ingestion when compared to placebo, rating of activation was significantly higher throughout the intervention. Furthermore, a combination of measures of activation and pleasure showed participants to be in a consistently higher activation-pleasure state with carbohydrate ingestion. Significant decreases in HDL-C and 2-hour fasted glucose levels were observed with carbohydrate ingestion whereas LDL-C, total cholesterol and triglyceride levels did not change. A secondary aim was to examine the impact of 10 weeks of spin classes on health and fitness parameters. Attending two spin classes per week, for 10 weeks significantly decreased waist-to-hip ratio however did not have any effect on other anthropometry, physiological, metabolic factors and quality of life. Nevertheless, the exercisers showed better physiological and cardiovascular fitness relative to non-exercisers.

5.1 The effect of regular carbohydrate ingestion during a 10-week exercise intervention on health and fitness parameters, mood and quality of life in recreational exercisers.

Carbohydrate is a popular ergogenic aid that has well-known performance benefits. Recent studies have also highlighted the effect of carbohydrate ingestion on perceived exertion as well as mood states (Backhouse et al., 2005). Therefore, carbohydrate ingestion during an exercise session has the potential to improve the quality of the exercise session by increasing the exercise intensity and further enhance the effect by improving mood states. This will be beneficial to the recreational exerciser by enhancing the ‘feel-good’ factor of exercise, which was shown to be the strongest predictor of long-term participation of exercise (Segar et al., 2011).

There was no significant change throughout the intervention in body mass, fat composition, waist-to-hip ratio, body mass index (BMI), resting heart rate, oxygen saturation rate, cardiorespiratory fitness ($\dot{V}O_2max$) and metabolic factors between the CHO and PLA groups. However significant decrease in resting diastolic blood pressure was observed between the two groups ($p = 0.02$). The resting diastolic pressure decreased by 5 mmHg in the CHO group while it increased by 2mmHg in the PLA group. The decrease in resting blood pressure has been associated with improved cardiovascular functions (Sallis et al., 1987) with regular exercise (Tully et al., 2005). Furthermore, carbohydrate ingestion during single bouts of exercise was shown to increase power output (El-Sayed et al., 1997) therefore allowing individuals to exercise at a higher intensity. Consequently, the decrease associated with CHO but not in PLA group may be an indication of improved cardiovascular functions by increased exercise intensity throughout the intervention. Glucose ingestion in healthy normal-weight volunteers in Brown et al. (2008) during rest showed no changes in diastolic pressure 2 hours after ingestion of carbohydrate or water. Therefore, as carbohydrate ingestion without exercise did not affect diastolic pressure, the current study’s results provide evidence of the effect of carbohydrate ingestion during exercise. However, without the changes in other physiological variables such as cardiorespiratory fitness, it shows only minor evidence of the benefits of carbohydrate ingestion during exercise on blood pressure.

The difference between pre- and post-intervention measures of the variables examined during an intervention, are used in most studies to measure the effects (Jasnoski et al., 1981; De Bock et al., 2009; Nybo et al., 2009). Compared to others, the current study conducted a measure of heart rate and various perceptual factors during individual training sessions throughout the 10-week duration to examine any changes throughout the intervention.

The mean heart rate was not different between CHO and PLA groups throughout the intervention (Figure 4.1). Fritzsche et al. (2000) and Hulson & Jeukendrup (2009) showed enhanced performance with carbohydrate ingestion during single bouts of exercise through increased power output and improved time trial performance. Therefore, carbohydrate ingestion is expected to enhance performance during individual exercise sessions, allowing the participants to exercise at a higher intensity. However, the lack of a difference between the two groups may suggest an improvement in the fitness level of the CHO participants. This was evident in Simons & Birkimer (1988) where an 8-week exercise intervention of jogging, walk-jogging, brisk walking and walking, showed a decrease in the mean exercise heart rate at the same relative intensity. In addition, fitter individuals showed a lower average heart rate during exercise (Skinner et al., 2003) by improvements in the cardiovascular fitness by myocardial hypertrophy, and increased stroke volume (Naumann et al., 2012). This shows that even if the participants were exercising at the same intensity, their recorded heart rate may have been lower towards the end of the trial compared to the start of the trial. The intensity during a single session of spin class fluctuates heavily (Caria et al., 2007). Therefore, the observed mean heart rate may not fully represent the dynamics of the exercise intensity. The measure of the proportion of time spent in the different heart rate zones, in the efforts to measure whether carbohydrate ingestion allowed exercising at higher intensities, was not different between CHO and PLA groups. Hulson & Jeukendrup (2009) showed improvements in the time trial performance with carbohydrate ingestion which demonstrated that exercise was performed at higher intensities. Therefore, according to Hulson & Jeukendrup (2009), an increase in the proportion of time spent at higher heart rate zones should have been observed in the CHO group. This was expected as ingested carbohydrate has shown to play a role in sparing of muscle glycogen, allowing participants to maintain or enhance performance (El-Sayed et al., 1997). Due to the changes observed in the heart rate with increasing fitness levels, examining the cardiac efficiency by measuring the heart rate while exercising at the same workload, might provide a better indicator of the effect of carbohydrate ingestion. Furthermore, as heart rates are influenced by factors such as dehydration and activity states, (Tendera M et al., 2007) the changes observed may have been due to external influences.

Exercise tests used to examine the effect of carbohydrate ingestion on exercise intensity in other studies were either through time trial performances or time to fatigue (El-Sayed et al., 1997; Halson et al., 2004; Kambis & Sheets, 2005; Hulston & Jeukendrup, 2009). The current study however examined the exercise intensity during group exercise sessions, where no specific goals were in place, but with continuous encouragement by the instructors. In addition, the zone calculation based on the estimated heart rate maximum in relation to age (Robinson, 1938) does not take resting heart rate into consideration. This should be avoided as fitter individuals are known to have lower resting heart rates (Fox et al., 2007). Therefore using the individual's actual maximum and resting heart rate will adjust the heart rate zones relative to the individual. Furthermore, heart rate zones with ranges those are narrower than one proposed by Halson et al. (2004) may be more efficient in examining the difference during the spin classes.

The working resistance during spin classes are self-adjustable therefore the perceived working resistance was measured in this study. However, the perceived working resistance was not significantly different between CHO and PLA groups throughout the intervention. This was supported by consistent RPE measured throughout the intervention. Rollo & Williams (2010) also observed consistent RPE during a 1-hour running performance with or without carbohydrate ingestion. On the other hand, Backhouse et al. (2005) observed continuous increases in RPE by both carbohydrate and placebo groups. However, RPE of the placebo group was higher at all points in time throughout the exercise trial (Backhouse et al., 2005). Therefore, the carbohydrate drinks diminished the perceived exertion throughout the exercise session. However, although non-significant, RPE of the CHO group showed an increasing trend whereas the PLA group showed a decreasing trend ($p = 0.05$). In conjunction with the no difference in the mean heart rate, this may suggest carbohydrate ingestion increased perceived exertion during exercise. On the contrary, Carter et al. (2003) showed lower RPE with carbohydrate ingestion with performance improvements, although no differences were seen in the mean heart rate throughout the exercise trial. The RPE ratings in the aforementioned studies were measured several times throughout a single bout of exercise. However the current study measured the RPE as an overall measure of the exercise sessions. Therefore, the overall ratings might have decreased the sensitivity of the scale hence dampening the changes that may have been present especially during periods of high-intensity exercise throughout the session in the current study. Furthermore, the duration of individual exercise sessions in the current study was 45 minutes whereas the exercise bout in Backhouse et al. (2005) was 120 minutes. The short duration of exercise conducted in the current study also may not have been long enough to observe a potential change. Nevertheless, incorporating an actual measure of exercise intensity and resistance would help to further explain these results; this was not possible in the current study as we did not have the appropriate equipment to measure actual power output.

In a 10-week intervention, Jasnoski et al., (1982) found that self-perceived abilities and self-confidence improved in conjunction with improved aerobic capacity. However self-perception was not related to changes in physical fitness. Accordingly, there were no significant changes in cardiorespiratory fitness however variability was seen in self-perception examined by the ratings of pleasure and activation. Although non-significant ($p = 0.28$), the mean ratings of pleasure were higher for all of the exercise sessions in the CHO group (Figure 4.6). This provides partial support of Backhouse et al. (2005) who found pleasure ratings became more positive and were maintained throughout exercise following carbohydrate ingestion, whereas ratings became less positive in the placebo trial. Furthermore, ratings of pleasure were higher with carbohydrate ingestion when compared to placebo throughout the exercise session (Backhouse et al., 2005). Moreover, similar to the current study, the exercise intensity and heart rate during the exercise testing did not differ between the CHO and PLA groups in Backhouse et al. (2005). Carter et al. (2004) also reported carbohydrate ingestion during relatively short high intensity exercise will have ergogenic effects although it was unlikely that the exogenous carbohydrate source influenced energy production within the muscle. However, as the ratings were asked retrospectively in the current study, this may not reflect the ratings during exercise but may be indicative of the ratings after exercise. This also presents a beneficial result as ingestion of carbohydrate enhanced the activation and pleasure rating post-exercise as observed in Backhouse et al. (2005). Consequently, the previously mentioned studies suggest a higher pleasure rating is perceived by individuals following carbohydrate ingestion during exercise at the same intensity in addition to prolonged effect after exercise.

Throughout the intervention, the CHO group reported higher, increasing ratings of perceived activation whereas PLA group reported reduced ratings that decreased with time ($p = 0.02$; Figure 4.6). Therefore, carbohydrate ingestion allowed participants to feel more ‘activated’ throughout the course of the intervention. On the contrary, Rollo & Williams (2010) showed no significant difference in the ratings of pleasure and activation during 1-hour exercise sessions between carbohydrate and placebo trials. This may have been due to the pre-exercise meal that replenished the carbohydrate required for the exercise bout. Furthermore, 67.6% of the total time spent exercising, was at 69 to 87% HRmax. As carbohydrate is the main substrate used in energy provision at high intensities, carbohydrate ingestion in the CHO group may have positively influenced the activation while having detrimental effects on the PLA group. Ratings of activation also showed weak associations with perceived working resistance ($r = 0.25$, $p < 0.01$) and RPE ($r = 0.21$, $p < 0.01$). The relative weak associations may have been due to the small sample size for an intervention study as other studies had eight (Nybo et al., 2009) to 10 participants (De Bock et al., 2008) per group. However due to limited resources and time constraints, the current study was limited to six participants per group. Although Nybo et al. (2009) and De Bock et al. (2008) had higher number of participants in each group, they did not recruit control participants. Furthermore, the sensitivity of the uni-dimensional properties of the ratings of FAS and FS, may not have been sufficient to detect a stronger association. Mood is a perceptual measure that is hard to quantify as it is a relative measure. Therefore, a multi-directional scale that incorporates the various factors that may influence mood, and also detect small changes may be beneficial in detecting a stronger association.

Backhouse et al (2005) suggested the use of both FS and FAS scales to present a more complete understanding of the subjective exercise experience. The combined effects of activation and pleasure-displeasure ratings were observed by the use of a 'circumplex model' (Russell, 1980). The model shows participants in the CHO group to be at a higher activation and pleasure state compared to the PLA group (Figure 4.7). This was supported by the weak, however positive correlation found between CHO group and, pleasure ($r = 0.27$, $p <0.01$) and activation ratings ($r = 0.32$, $p <0.01$). This suggests that in all sessions throughout the intervention, the CHO group were in the high-activation, pleasure quadrant whereas only 60% of the sessions were in the 'high-activation, pleasure' quadrant for the PLA group. In addition, the measures of PLA were more scattered in the plot in comparison to CHO where it was more consistent. The 'high-activation, pleasure' quadrant is associated with energy, vigour, excitement and revitalisation whereas decreased activation and pleasure ratings are associated with calmness, relaxation as well as tiredness and boredom (Ekkekakis et al., 2011). Ekkekakis et al. (2000) showed that exercising at moderate intensity was associated with a shift toward increased activation and more positive affective valence. Moreover, participants that were asked to be seated for the duration were always in the 'low-activation, pleasure' state. Vigorous exercise was also associated with directional changes towards 'high-activation, displeasure' state (Hall et al., 2002). Therefore the current study's findings suggest carbohydrate ingestion during exercise has beneficial effects in perceived activation and pleasure state and enhances the 'feel-good' aspects of exercise. Furthermore, as both groups in the current study attended the same exercise sessions, exercise itself has shown to have potential benefits in the pleasure and activation ratings of individuals. However, with carbohydrate ingestion, these effects were enhanced.

Carbohydrate ingestion during exercise has also been shown to attenuate cerebral uptake of tryptophan, a precursor to serotonin, compared to water (Blomstrand et al., 2005). Carbohydrate ingestion also attenuated perceived exertion, which suggested that the decreased uptake of tryptophan decreases serotonin levels in the brain (Blomstrand et al., 2005). Therefore, carbohydrate ingestion may decrease the uptake of tryptophan, decreasing serotonin production in the brain and assisting in an improvement of mood and reduce mental fatigue during exercise. In addition, regular ingestion of carbohydrate during exercise may have accumulative effects. Interestingly the changes in the 2-hour fasted glucose levels pre- and post-intervention in the CHO group showed a decrease of 0.9 mmol/L, whereas an increase of 0.9 mmol/L was seen in the PLA group ($p = 0.01$). However, the associated decrease in HDL-C levels (0.10 mmol/L; $p = 0.04$) in the CHO group and an increase in the PLA group (0.03 mmol/L) indicate that the changes are likely due to external factors that were not controlled in the current study, such as dietary intake. The decrease in the level of HDL-C in the current study may pose negative evidence against regular use of carbohydrate intake. However, as dietary intake plays a huge part in the level of cholesterol, this only presents weak evidence. To show an accurate picture of the mechanism behind the effect of glucose, examination of the levels of cerebral serotonin activity during exercise, observation of plasma tryptophan and glucose levels, in addition to controlling the dietary intake would allow a clearer evidence to support and explain the mechanism.

Several factors in the current study may have influenced the results compared to other studies. In addition to the duration of the exercise bouts, and timing of perceptual measures as mentioned above, fitness levels of participants in the current study compared to other studies are different. The participants of Halson et al. (2004) were endurance-trained cyclists who had at least 5 years of training with higher $\dot{V}O_2max$ (61.9 mL/kg/min) compared to the current study's participants (42.2 mL/kg/min). The participants of Halson et al. (2004) were also comparatively younger (29.7 years old) than the current study's cohort (46.0 years old). Furthermore, Backhouse et al. (2005) used endurance-trained male participants with $\dot{V}O_2max$ of 64.7 mL/kg/min at baseline. Further differences in post-prandial triglyceride concentrations were observed between the recreational exercisers and endurance trained participants (Ziogas et al., 1997). Therefore, the physiological differences between the well-trained/elite athletes and recreational exercisers may have produced different responses to carbohydrate ingestion during exercise.

Furthermore, the dosage of carbohydrate drinks differed from other studies. The current study's participants were provided with a 7.5% carbohydrate solution at 5 mL/kg BM per session (average of 353.8 ± 64.0 mL provided per session, per person). However, Halson et al. (2004), who observed a decrease in heart rate during the endurance capacity test after two weeks of normal and intensified training, provided their participants 500 mL of a 6.4% carbohydrate solution before and after every hour of training. Furthermore, the participants of Backhouse et al. (2005) were provided with 6.4% CHO at 5 mL/kg BM just prior to exercise, and every 15 minutes thereafter. Therefore, relative dosage and timing of ingestion was different in the current study compared to both Halson et al.

(2004) and Backhouse et al. (2005). Increased dosage may have been required to observe a potential influence of carbohydrate ingestion.

A significantly higher proportion of participants (83% in both CHO and PLA groups) did not habitually take carbohydrate drinks during exercise. Furthermore, although non-significant, the majority (83% in both CHO and PLA groups) of the participants did not eat prior to attending the exercise sessions. The exercise sessions were either at 6.00 am or 6.15 pm, which were at times when most of the participants would have just woken up or have finished from work. Pre-exercise meals have shown to influence exercise performance as well as influence the potential effects of carbohydrate ingestion during exercise (McConell et al., 2000). As mentioned above, the uncontrolled dietary intake was a limitation in this study. Furthermore, the current study did not restrict participation of exercise outside of the intervention. The potential placebo effects were avoided in the current study as more than half of the participants (58.4%) did not know which group they were allocated to, or guessed incorrectly. Future studies should continue using placebo treatments as well as control for dietary and exercise participation external to the study.

5.2 The effect of 10 weeks of cycling exercise on health and fitness parameters.

The beneficial effects of exercise have been highlighted by numerous studies over the years (Jasnoski et al., 1981; Miller et al., 1997; Fogelholm et al., 2000; Hallstrand et al., 2000). However, the current study did not show any significant difference in changes of body mass, fat composition, BMI, resting heart rate, blood pressure and cardiorespiratory fitness following the intervention in the exercise relative to control groups (Table 4.5). Intervention studies conducted to examine the effect of regular exercise have shown improvements in the aforementioned variables, which are associated with decreases in the risk factors of several chronic diseases (Jasnoski et al., 1981;

Svendsen et al., 1993; Miller et al., 1997). However, the aims of these studies were to improve health and fitness parameters by either weight-loss or rehabilitative training (Svendsen et al., 1993; Fogelholm et al., 2000). The only significant difference in the changes pre- and post-intervention between the two groups in the current study was the waist-to-hip ratio ($p = 0.03$; Table 4.5). Similarly, Svendsen et al. (1993) found decreases in waist-to-hip ratio and fat composition through a 10-week exercise intervention. On the other hand, they also found significant improvements in aerobic capacity. However, Svendsen et al. (1993) used the 12-minute walk/run test that required maximal exercise efforts for 12 minutes, while the incremental cycling protocol was used in the current study. Nybo et al. (2009) using the same cycling protocol as the current study, observed an increase in the aerobic capacity through an 8-week exercise intervention; however the total training time was 44.5 hours whereas the total training time for the current study was 15 hours. Furthermore, participants in Nybo et al. (2009) were individuals that had not been taking part in any regular exercise in the 6 months preceding the study whereas the current study used participants that were already regular exercisers. This was evident in the significantly lower BMI ($p = 0.03$), resting heart rate ($p < 0.01$) and higher $\dot{V}O_2max$ ($p < 0.01$) at baseline compared to the CON group.

Most recent studies however show significant improvements in cardiorespiratory function through exercise interventions (De Bock et al., 2008; Nybo et al., 2009; Simons & Birkimer, 1987). Accordingly, the participants in Nybo et al. (2009) at baseline had a $\dot{V}O_2max$ of 38 mL/kg/min which was lower than the $\dot{V}O_2max$ of participants in the current study (42.2 mL/kg/min). Therefore the higher baseline $\dot{V}O_2max$ in the current study may have limited the potential for improvements in cardiorespiratory fitness. Furthermore, as $\dot{V}O_2max$ is thought to be predisposed to a set threshold influenced by biological makeup, (Astrand & Rhyming, 1954; Levine, 2008) the participants of the EXE cohort in the current study may have reached their predetermined maximum. In conjunction with the higher $\dot{V}O_2max$, resting heart rate was higher in CON compared to EXE at baseline ($p < 0.01$).

This is expected as fitter individuals are known to have lower resting heart rates as the efficiency of the heart is enhanced by an increase in the stroke volume and hypertrophy of the ventricular muscle (Nauman et al., 2012). At baseline, resting heart rate of CON was higher (77 beats/min) than EXE (62 beats/min; $p < 0.01$) and the resting heart rate observed by the CON group is associated with a higher rate of hazard ratio in both overall and cardiovascular mortality (Fox et al., 2007). Lower resting heart rates are also associated with decreased risk of cardiovascular disease and overall mortality (Fox et al., 2007). Therefore, at baseline, the participants of the EXE cohort were shown to be in a superior health and fitness state compared to the CON group.

The aforementioned studies were conducted using normally sedentary participants (Simons & Birkimer, 1987; Tully et al., 2005; Nybo et al. 2009) and participants in the lowest quintile of cardiorespiratory fitness showed the most improvement if they changed from a sedentary to an active lifestyle (Cheng et al., 2002).The participants in Tully et al. (2005) were excluded if they participated in regular exercise and had to have a BMI of over 35 kg/m^2. Therefore, studies conducted on sedentary individuals had large potentials for improvements. Therefore, although the benefits of regular exercise on sedentary populations are pronounced, the effects of regular exercise in individuals that partake in regular activities are not well-known.

The 'work' subscale of the IWQOL-Lite at baseline was lower in the CON group ($p = 0.03$). This relates to the inability to accomplish or meet their responsibilities at work, decreased productivity, insufficient recognition and self-conscious to attend job interviews. Although non-significant, the largest variation seen between the five factors of the IWOQL-Lite questionnaire was self-esteem. Both EXE and CON groups showed an increase in self-esteem of 3.2 and 3.6 respectively ($p = 0.85$). However, the EXE cohort reported a score of 83.2 whereas CON group reported a score of 66.8 ($p = 0.10$). This shows that individuals that exercise regularly may have higher levels of self-esteem. As seen from above, the characteristics of the participants in the EXE cohort suggests they had superior health and fitness state. Therefore, although the current study did not find any significant differences in the self-esteem levels throughout the 10-week intervention, their habitual participation of exercise may have had a positive impact on their self-esteem. Studies showed group fitness class enhanced self-esteem through socialisation (William & Lord, 1997; Wilcox et al., 2006; Barton et al., 2012). Therefore, the difference between the EXE cohort and CON group may have been due to the lack of socialisation in the CON group. On the contrary, it may also mean that participants with higher self-esteem choose to exercise regularly. Annisi (2012) proposes that an increase in mood is associated with a higher volume of exercise as well as enhanced self-efficacy. Moreover, this has the potential to have an overall impact on the quality of life. Therefore, a questionnaire sensitive enough to measure changes in small sample size may have been able to capture a potential change in the quality of life of the participants in this study. Laforge et al. (1999) observed an association between exercise and self-perceived quality of life and in addition, were strongly related to physical functioning, general health perception and vitality (Laforge et al., 1999). The IWQOL-Lite used in the current study may not have been suitable for this study as it was focused mainly on obesity aspects. Furthermore, the current study had lower number of participants compared to other studies that utilised this questionnaire (Kolotkin & Crosby, 2002). Therefore, the use of a QoL questionnaire based on regular exercisers might have been better suited for the current study.

5.3 Conclusions

- Regular ingestion of 5mL/kg BW of 7.5% carbohydrate during 45 minute cycling exercise two times per week, improved perceived activation throughout the 10-week intervention. In addition, carbohydrate ingestion resulted in a higher activation-pleasure state compared to placebo ingestion throughout the intervention.

- Carbohydrate ingestion showed a weak positive association with perceived working resistance, and ratings of activation and pleasure.
- Regular carbohydrate ingestion decreased resting diastolic blood pressure however did not have an effect in other health and fitness parameters.
- Participation in 45-minute spin classes, two times per week decreased the waist-to-hip ratio however did not have an effect on other health and fitness parameters.

5.4 Limitations and future directions

- The duration of the study may need to be lengthened to observe the changes in the ratings of pleasure and activation as it showed the potential to change towards the end of the intervention.
- Sample size was estimated using power calculations based on the data from Svendsen et al. (1993). A sample size of 16 per group was considered sufficient, however to allow for participant drop-out the aim was to recruit 20 participants per group. Therefore a larger sample size may benefit future studies as the current study had only six participants per group.
- Glucose testing during individual sessions to measure the levels of glucose pre- and post-exercise will provide more in-depth evidence to analyse the associations of physiological changes with the perceptual changes throughout the intervention.
- Dietary intake and other activities outside of the intervention should be recorded to enhance control of external factors that may influence the study.

- The quality of life questionnaire used in this study was focused on an obese population. Therefore, questionnaires that are more suited to the participants are recommended for future studies.
- Actual measures of exercise intensity and resistance, in addition to the perceived measures, would help identify the potential effect of carbohydrate ingestion.
- Research into the use of carbohydrate ingestion during exercise in recreational exercisers is needed to provide recommendations of carbohydrate ingestion that is more suitable for their physique.

6.0 References

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7.0 Appendices

Appendix 1: Participant information sheet (Exercise)

Appendix 2: Advertisement (Exercise)

Appendix 3: Advertisement 1 (Control)

Appendix 4: Advertisement 2 (Control)

Appendix 5: Participant information sheet (Control)

Appendix 6: Screening Questionnaire (Exercise)

Appendix 7: Screening Questionnaire (Control)

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Appendix 10: Training and Monitoring log

Appendix 11: Health Screening Questionnaire

Appendix 12: Impact of Weight on Quality of Life Questionnaire – Lite (IWQOL-Lite)

Appendix 13: Borg’s Ratings of Perceived Exertion (RPE)

Appendix 14: Feeling Scale (FS)

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Appendix 17: Letter requesting permission to recruit from ASFC

Appendix 1

MASSEY UNIVERSITY
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TE WĀHANGA PŪTAIAO

Effect of carbohydrate ingestion during exercise on health, fitness, quality of Life and mood

PARTICIPANT INFORMATION SHEET (Intervention group)

Invitation to Participate in Research Study

We, Ms. Vivian Lee, Dr. Ali and Dr. Rutherfurd-Markwick are researchers at Massey University and are currently conducting a study examining the effects of carbohydrate intake during exercise on health, fitness, mood and quality of life. This is a study for a Master's Degree at Massey University. Carbohydrate is known to be a performance enhancing ergogenic aid and is an important macronutrient in energy provision during exercise, as well as being the only fuel for the central nervous system. Consequently carbohydrate has also been shown to enhance mood and improve fatigue. This in turn leads us to the possibility of utilizing carbohydrate as an exercise-enhancing supplement during exercise to improve health, fitness, quality of life and mood.

Participant Recruitment

We are looking for 40 participants between the ages of 30 to 60 to participate in this study. To participate in the study you will need to be attending 2 - 3 RPM classes per week.

You will be informed verbally of the aims, procedures and demands and any potential risks and discomfort that the study will entail. Written consent will then be obtained from you; please note that you will still retain the right to withdraw from the study, without reason, at any stage.
You will be asked to complete a general health-screening questionnaire before taking part in any aspects of this study. Individuals reporting any current or previous medical conditions indicated in this form will be excluded from the study.

Project Procedures and Participant Involvement

Participants will firstly be screened for their eligibility for this study.

You will initially undergo pre-intervention testing which will include measuring anthropometrics (height, weight, hip and waist circumference) and body composition, resting blood pressure and heart rate, collection of blood and saliva, and a fitness test. Each intervention testing will take approximately 1.5-2 hours. Body composition will be measured using air displacement plethysmography (BodPod) and resting blood pressure and heart rate will be measured with appropriate equipment. BodPod is the latest state-of-the art equipment that uses air displacement plethysmography to measure body composition. Blood (venepuncture) and saliva sample will be collected once pre- and post- intervention to analyse metabolic (glucose, insulin, cholesterol and free-fatty acids) and immune function. The fitness test consists of a 16-minute incremental cycling test using a cycle ergometer. The exercise intensity increases every 4 minutes and between those times, variables (heart rate and expired gas analysis via the use of Douglus bags) will be measured to assess your fitness level. You will also be asked to complete two questionnaires, Quality of Life Questionnaire and Profile of Mood Questionnaire (POMS).

During the 10-week intervention, you will be randomized into either a placebo group or an experimental group. The drink will consist of 3ml/kg of your body mass and will be provided prior to each exercise session to be taken during the session. Following the pre-intervention testing, all participants will be given a training/monitoring log to be completed after each exercise session. This will be used to record your exercise intensity and other perceptual variables. Each exercise session will consist of the 45-min RPM classes that you normally attend.

Post-intervention will consist of the tests carried out in the pre-intervention testing.

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All participants will be given a copy of their health and fitness post- intervention. In addition, the summary of the study will be available to the participants. If any abnormal results are found during the analysis, we will inform you of the findings and refer you an appropriate specialist for a formal check-up.

Participant's Rights
You are under no obligation to accept this invitation. Should you choose to participate, you have the right to:
• decline to answer any particular question
• withdraw from the study at any time, even after signing a consent form (if you choose to withdraw you cannot withdraw your data from the analysis after the data collection has been completed)
• ask any questions about the study at any time during participation
• provide information on the understanding that your name will not be used unless you give permission to the researcher
• be given access to a summary of the project findings when it is concluded

Confidentiality
All data collected will be used solely for research purposes and has the possibility of being presented in a professional journal. All personal information will be kept confidential by assigning numbers to each participant. No names will be visible on any papers on which you provide information. All data/information will be dealt with in confidentiality and will be stored in a secure location for five years on the Massey University Albany campus. After this time it will be disposed of by an appropriate staff member from the School of Sport and Exercise and/or Institute of Food, Nutrition, and Human Health.

Project Contacts
If you have any questions regarding this study, please do not hesitate to contact either of the following people for assistance:

Researchers: Vivian Lee (School of Sport and Exercise, Massey University),
021 164 7325; happycarbstudy@gmail.com

Supervisor: Dr. Ajmol Ali (School of Sport and Exercise, Massey University)
(09)414-0800 ext.41184; a.ali@massey.ac.nz

Dr. Kay Rutherfurd-Markwick (IFNHH, Massey University)
(09) 414-0800 ext. 41141; k.j.rutherfurd@massey.ac.nz

Committee Approval Statement
This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 12/06. If you have any concerns about the conduct of this research, please contact A/Prof Hugh Morton, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 350 5799 x 4265, email humanethicsoutha@massey.ac.nz.

Compensation for Injury
If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Injury Prevention, Rehabilitation and Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury. If your ACC claim is not accepted you should immediately contact the researcher. The

researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

Appendix 2

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Are you curious about your fitness level or your body composition?

Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who exercise regularly, to join our study.

The participants will be participating in a 10-week exercise intervention study comparing the effect of carbohydrate drink in measuring health, fitness, quality of life and mood. All the selected participants will be asked to come in twice, separated by a 10-week period to measure their body composition, and other health and fitness parameters.

For a chance to measure your body composition with the latest state-of-the art equipment, and also for a chance to measure your health and fitness parameters, please contact Vivian by phone or e-mail!

Phone: 021 164 7325

Email: happycarbstudy@gmail.com

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Appendix 3

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Are you curious about your body composition? Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who do not participate in regular exercise, to join our study.

For a chance to measure your body composition with the latest state-of-the art equipment, please contact Vivian by phone or e-mail!

Phone: 021 164 7325
Email: happycarbstudy@gmail.com

Appendix 4

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Are you curious about your body composition?

Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who do not participate in regular exercise, to join our study in measuring body composition.

The participants are required to act as the control group for a study that requires an exercising group and a non-exercising group. The exercising group will be participating in a 10-week exercise intervention study comparing the effects of carbohydrate drink on health, fitness, quality of life and mood. All the selected participants will be asked to come in twice, separated by a 10-week period to measure their body composition, and other health and fitness parameters.

For a chance to measure your body composition with the latest state-of-the art equipment, please contact Vivian by phone or e-mail!

Phone: 021 164 7325

Email: happycarbstudy@gmail.com

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Appendix 5

MASSEY UNIVERSITY
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Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

PARTICIPANT INFORMATION SHEET (Control group)

Invitation to Participate in Research Study

We, Ms. Vivian Lee, Dr. Ali and Dr. Rutherfurd-Markwick are researchers at Massey University and are currently conducting a study examining the effects of carbohydrate ingestion during exercise on health, fitness, mood and quality of life. This is a study for a Master's Degree at Massey University. A well designed study requires a control group that acts as the baseline of all measurements. Hence, we are looking to recruit participants to take part in the control group for this study. Potential participants will enjoy the opportunity to assess their health and fitness parameters as well as their mood and quality of life.

Participant Recruitment

We are looking for 20 participants between the ages of 30 to 60 to participate in this study. To participate in the study you will not be taking part in any regular exercise.

You will be informed verbally of the aims, procedures and demands and any potential risks and discomfort that the study will entail. Written consent will then be obtained from you; please note that you will still retain the right to withdraw from the study, without reason, at any stage.

You will be asked to complete a general health-screening questionnaire before taking part in any aspects of this study. Individuals reporting any current or previous medical conditions indicated in this form will be excluded from the study.

Project Procedures and Participant Involvement

Participants will firstly be screened for their eligibility for this study.

You will initially undergo pre-intervention testing which will include measuring anthropometrics (height, weight, hip and waist circumference) and body composition, resting blood pressure and heart rate, collection of blood and saliva, and a fitness test. Each intervention testing will take approximately 1.5-2 hours. Body composition will be measured using air displacement plethysmography (BodPod) and resting blood pressure and heart rate will be measured with appropriate equipment. BodPod is the latest state-of-the art equipment that uses air displacement plethysmography to measure body composition. Blood (venepuncture) and saliva sample will be collected once pre- and post- intervention to analyse metabolic (glucose, insulin, cholesterol and free-fatty acids) and immune function (). The fitness test consists of a 16-minute incremental cycling test using a cycle ergometer. The exercise intensity increases every 4 minutes and between those times, variables (heart rate and expired gas analysis via the use of Douglus bags) will be measured to assess your fitness level. You will also be asked to complete two questionnaires, Quality of Life Questionnaire and Profile of Mood Questionnaire (POMS). During the 10-week intervention period you will be asked to record your activation/arousal measures in a logbook. Following this period you will be asked to come back to the laboratory for post-intervention measures.

All participants will be given a copy of their health and fitness post- intervention. In addition, the summary of the study will be available to the participants. If any abnormal results are found during the analysis, we will inform you of the findings and refer you an appropriate specialist for a formal check-up.

Participant's Rights

You are under no obligation to accept this invitation. Should you choose to participate, you have the right to:

• decline to answer any particular question

• withdraw from the study at any time, even after signing a consent form (if you choose to withdraw you cannot withdraw your data from the analysis after the data collection has been completed)

- ask any questions about the study at any time during participation
- provide information on the understanding that your name will not be used unless you give permission to the researcher
- be given access to a summary of the project findings when it is concluded

Confidentiality

All data collected will be used solely for research purposes and has the possibility of being presented in a professional journal. All personal information will be kept confidential by assigning numbers to each participant. No names will be visible on any papers on which you provide information. All data/information will be dealt with in confidentiality and will be stored in a secure location for five years on the Massey University Albany campus. After this time it will be disposed of by an appropriate staff member from the School of Sport and Exercise and/or Institute of Food, Nutrition, and Human Health.

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021 164 7325; happycarbstudy@gmail.com

Supervisor: Dr. Ajmol Ali (School of Sport and Exercise, Massey University)
(09)414-0800 ext.41184; a.ali@massey.ac.nz

Dr. Kay Rutherfurd-Markwick (IFNHH, Massey University)
(09) 414-0800 ext. 41141; k.j.rutherfurd@massey.ac.nz

Committee Approval Statement

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Compensation for Injury

If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Injury Prevention, Rehabilitation and Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury. If your ACC claim is not accepted you should immediately contact the researcher. The researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

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Screening Questionnaire (Intervention Group)

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Thank you for your interest in this study. We need to ask you a few questions to make sure you are suitable for this study. To participate in this study, you need to be between 30 – 60 years of age and attend at least 2 – 3 RPM classes per week for 10 weeks.

Name: ________________________________ Participant ID: ___________________

Date of Birth: _______/______/______(DD/MM/YY)

Sex: Male/ Female

Phone number: _______________________________

Address: ____

E-mail: ____

What is the best way of contacting you? *(Please circle most appropriate answer)*

Post / e-mail / telephone

Are you proficient in English?

Yes / No

Do you attend at least 2-3 RPM classes per week?

Yes / No

Will you be continuously attending the RPM classes for the next 4 months?

Yes / No

Are you able to come in to Massey University Albany Campus twice, separated by approximately 10 weeks?

Yes / No

Thank you for your time☺.

Appendix 7

MASSEY UNIVERSITY
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Screening Questionnaire (Control Group)

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Thank you for your interest in this study. We need to ask you a few questions to make sure you are suitable for this study. To participate in this study, you need to be between 30 – 60 years of age and do not participant in regular activity.

Name: ________________________________ Participant ID:___________________

Date of Birth: _______/______/______(DD/MM/YY)

Sex: Male/ Female

Phone number: _______________________________

Address: ____

E-mail: ____

What is the best way of contacting you? *(Please circle most appropriate answer)*

Post / e-mail / telephone

Are you proficient in English?

Yes / No

Do you participate in regular activity (this includes going to the gym or playing recreational sports)?

Yes / No

Are you able to come in to Massey University Albany Campus twice, separated by approximately 10 weeks?

Yes / No

Thank you for your time☺.

MASSEY UNIVERSITY
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Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

CONSENT FORM FOR STUDY VOLUNTEERS

This consent form will be held for a minimum period of five (5) years

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I understand that I have the right to withdraw from the study at any time and to decline to answer any particular questions.

I agree to provide information to the researcher on the understanding that my name will not be used without my permission. (The information will be used only for this research and publications arising from this research project).

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: ____ **Date**____________________

Full Name (printed)

____

Phone Number_______________________ **Age** _______________ **Date of Birth** _________

Participant code ☐

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Appendix 9

Massey University
Te Kunenga ki Pūrehuroa

Application No: _____ / ___________
This number is assigned when your application is accepted.
Quote on all documentation to participants and the Committee.

Human Ethics Application

FOR APPROVAL OF PROPOSED RESEARCH/TEACHING/EVALUATION INVOLVING HUMAN PARTICIPANTS

(All applications are to be typed and presented using language that is free from jargon and comprehensible to lay people)

SECTION A

1 Project Title Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Projected start date for data collection April 2012 **Projected end date** March **2013**

(In no case will approval be given if recruitment and/or data collection has already begun).

2 Applicant Details *(Select the appropriate box and complete details)*

ACADEMIC STAFF APPLICATION (excluding staff who are also students)

Full Name of Staff Applicant/s

School/Department/Institute

Campus *(mark one only)* **Albany** [ ] **Palmerston North** [ ] **Wellington** [ ]

Telephone **Email Address**

STUDENT APPLICATION

Full Name of Student Applicant Vivian Ye Jee Lee

Employer (if applicable)

Telephone 0211647325 **Email Address** dpwlek@hotmail.com

Postal Address 5 Alicia Road Howick, Auckland 2014, New Zealand

Full Name of Supervisor(s) Dr Ajmol Ali and Dr Kay Rutherfurd-Markwick

School/Department/Institute School of Sport and Exercise, IFNHH

Campus *(mark one only)* **Albany** [X] **Palmerston North** [ ] **Wellington** [ ]

Telephone Ext 41184, 41141 **Email Address** a.ali@massey.ac.nz, k.j.rutherfurd@massey.ac.nz

GENERAL STAFF APPLICATION

Full Name of Applicant

Section

Campus *(mark one only)* **Albany** [ ] **Palmerston North** [ ] **Wellington** [ ]

Telephone **Email Address**

Full Name of Line Manager

Section

Telephone **Email Address**

3 Type of Project *(provide detail as appropriate)*

Staff Research/Evaluation:		**Student Research:**		**If other, please specify:**
Academic Staff		**Specify Qualification**	**MSc**	
General Staff		**Specify Credit Value of Research**	**120**	
Evaluation		**(e.g. 30, 60, 90, 120, 240, 360)**		

4 Summary of Project

Please outline in no more than 200 words in lay language why you have chosen this project, what you intend to do and the methods you will use.

(Note: All the information provided in the application is potentially available if a request is made under the Official Information Act. In the event that a request is made, the University, in the first instance, would endeavour to satisfy that request by providing this summary. Please ensure that the language used is comprehensible to all.)

Carbohydrate (CHO) intake, especially 'sugary' sports drinks, is perceived to be detrimental for health and weight management (Bray et al., 2004). However, CHO is an important macronutrient for energy provision during exercise (El-Sayed et al., 1997), as well as fuel for the central nervous system (Ivy, 1999). Therefore, CHO intake is a well known performance-enhancing ergogenic aid (Hulston and Jeukendrup, 2009). In addition, CHO is also known to influence mood (Benton & Owens, 1993) and lead to more pleasurable feelings during exercise (Backhouse et al., 2007).

' Spin' classes are becoming increasingly popular group-fitness cycling sessions where participants work at self-selected exercise intensities. CHO supplements may allow these recreational exercisers to increase energy expenditure during exercise, enhance their 'affect', mood and improve health and fitness parameters.

Therefore, this study will examine the influence of CHO intake during 2-3 x 45-min spin classes per week, over a 10-week intervention period, on health and fitness parameters in recreational exercisers. Participants will be randomly allocated to experimental (7% CHO solutions; 3 ml/kg body mass per exercise session) or placebo (0% CHO taste- and volume-matched solutions) groups. A further control group (age and gender-matched) will be recruited to examine the effect of exercise (spin classes) alone on health and fitness parameters. Body composition (BodPod), cardiovascular fitness (cycling test), anthropometric measures, metabolic (blood sample) and immune (saliva sample) markers, mood state and quality of life (questionnaires) will be measured pre- and post-intervention in all participants.

5 List the Attachments to your Application, e.g. Completed "Screening Questionnaire to Determine the Approval Procedure" (compulsory), Information Sheet/s *(indicate how many)*, Translated copies of Information Sheet/s, Consent Form/s *(indicate of how many)*, Translated copies of Consent Form/s, Transcriber Confidentiality Agreement, Confidentiality Agreement *(for persons other than the researcher / participants who have access to project data)*, Authority for Release of Tape Transcripts, Advertisement, Health Checklist, Questionnaire, Interview Schedule, Evidence of Consultation, Letter requesting access to an institution, Letter requesting approval for use of database, Other *(please specify)*.

Screening Questionnaire
Information Sheet (Control and Exercise group)
Consent form
Training/Mood log (Control and Exercise group)
Health Screening Questionnaire
Advertising Poster
Quality of Life Questionnaire
Profile of Moods State (POMS) Questionnaire
Feeling Scale (FS)
Felt Arousal Scale (FAS)
Ratings of Perceived Exertion (RPE) scale
Letter to recruit participants

Applications that are incomplete or lacking the appropriate signatures will not be processed. This will mean delays for the project.

Please refer to the Human Ethics website (http://humanethics.massey.ac.nz) for details of where to submit your application and the number of copies required.

SECTION B: PROJECT INFORMATION

General

6	**I/We wish the protocol to be heard in a closed meeting (Part II).** *(If yes, state the reason in a covering letter.)*	**Yes**		**No**	X
7	**Does this project have any links to previously submitted MUHEC or HDEC application(s)?**	**Yes**	X	**No**	

If yes, list the MUHEC or HDEC application number/s (if assigned) and relationship/s.

MUHEC Southern A: 07/025 VO_2 peak test performed on a cycle ergometer and also the use of various perceptual scales (e.g. RPE, FS, FAS, and POMS) to assess mood and perceived exertion during such exercise.

MUHEC Southern A: 10/86 – Blood sampling for metabolic markers, including the use of perceptual scales (e.g. RPE, FS, FAS, POMS) to assess mood and perceived exertion during exercise.

MUHEC Southern a: 11/86 –Saliva sampling conducted on exercising participants to measure concentration of electrolytes, protein, salivary enzyme and immunoglobulin-A.

8	**Is approval from other Ethics Committees being sought for the project?**	**Yes**		**No**	X

If yes, list the other Ethics Committees.

9	**For staff research, is the applicant the only researcher?**	**Yes**		**No**	

If no, list the names and addresses of all members of the research team.

Project Details

10 State concisely the aims of the project.

The primary aim of this study is to examine the effect of CHO ingestion during a 10-week exercise regime on health and fitness parameters, mood and quality of life in recreational exercisers. A second aim is to examine the effect of 10 weeks of spin classes on health and fitness parameters.

11 Give a brief background to the project to place it in perspective and to allow the project's significance to be assessed. *(No more than 200 words in lay language)*

'Sugary' CHO drinks are found to be detrimental in health and weight management (Bray et al., 2004). However CHO is an important macronutrient for energy provision to the muscle as well as being the only fuel for the central nervous system (CNS). 'Acute' studies (single exercise sessions) with CHO ingestion during exercise using elite athletes show improved exercise performance (Nicolas et al., 1995), pleasurable feelings (Backhouse et al., 2007), and improvements in immune function (Bishop et al., 1999). However, there are no studies examining the effects of CHO ingestion during multiple exercise sessions on recreational exercisers.

Fitness classes are commonly enjoyed by recreational exercisers and 'spin' classes are fast becoming one of the most enjoyed fitness classes. Spin classes are taken by taught instructors and, with the use of spin bikes, the exercise intensity and resistance are self-adjustable.

CHO ingestion during exercise has been shown to increase work rate (El-Sayed et al., 1996) and hence, if provided during exercise, may lead to an increase in exercise intensity. Continual exercise (over multiple sessions) at a higher work rate may in turn improve health and fitness parameters. Thus the primary aim of this study is to examine the effect of CHO ingestion during a 10-week exercise regime on health and fitness parameters, mood, and quality of life in recreational exercisers. The secondary aim is to examine the effect of 10 weeks of spin classes on health and fitness parameters.

12 **Outline the research procedures to be used, including approach/procedures for collecting data. Use a flow chart if necessary.**

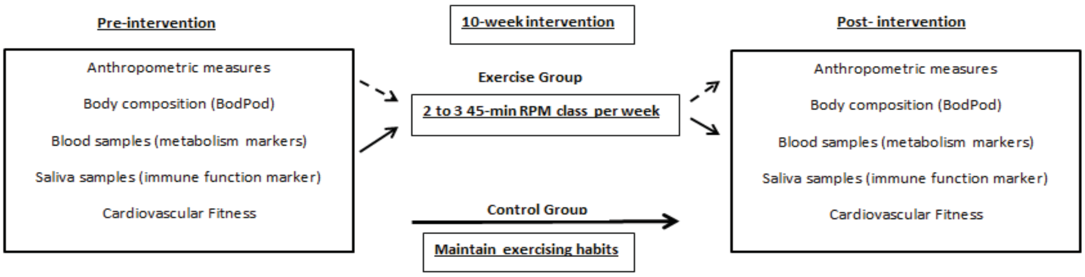

Figure 1. Outline of the intervention measures. In the exercise group, full line represents the placebo group and the dotted line represents the CHO group.

Participants will be asked to come into the laboratory following an overnight fast (only water allowed) for pre-intervention measurements (Figure 1). For the exercise groups participants will be randomly selected (stratified by age and gender) into CHO and placebo groups. In the CHO trial participants will be asked to consume 3 ml/kg body mass per exercise session (2-3 times/week) of a 7% CHO solution during the 10-week intervention period. In the placebo trial participants will be asked to consume 3 ml/kg body mass taste-matched 0% CHO solution during exercise. The control group will be asked to maintain their normal dietary and exercise habits during the 10-week intervention period. All participants will then return for the post-intervention measurements (Figure 1). The 10-week intervention for the exercise group will consist of 2 - 3 spin 45-min spin classes per week.

Anthropometric measures

Participant's height, weight, and hip and waste circumference will be measured pre- and post- intervention.

Heart rate

Resting heart rate in both control and exercise groups will be measured pre- and post- intervention. In the exercise group, heart rate will also be measured during individual exercise session using the Team Polar heart rate monitor.

Blood Pressure

Resting blood pressure will be measured using a sphygmomanometer and stethoscope pre- and post- intervention in both control and exercise group.

Cardiovascular fitness

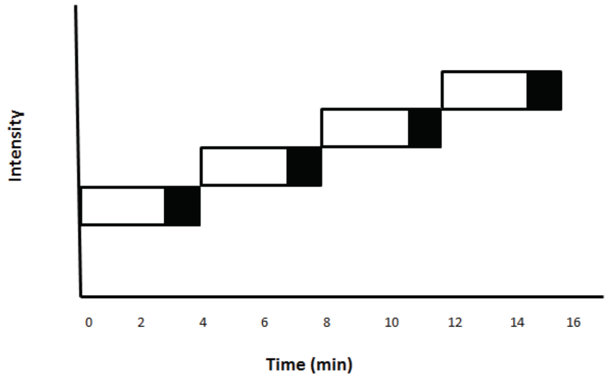

Figure 2. The 16-min incremental cycling protocol. Every 4th minute, RPE and expired air will be collected.

The participants will perform a 16-min incremental cycling protocol (Figure 2) to assess their cardiovascular and cardiorespiratory fitness levels by examining the relationship between a) work rate and heart rate, b) work rate and ventilation rate and c) work rate and oxygen uptake. This requires the participant to cycle at 60 rpm continuously for 16 minutes on an electromagnetically-braked cycle ergometer with increasing exercise intensities. Expired air and RPE will be collected every 4th minute and analysed to estimate exercise efficiency. Heart rate will be continuously measured with a Polar heart rate monitor. The Astrand-Rhyming (Astrand & Rhyming, 1954) method will be utilized to estimate maximal oxygen uptake (VO_2max).

Metabolism markers

Blood samples (~10 mL per sample) will be taken twice per participant (pre- and post- intervention) via venepuncture. Blood samples will be centrifuged and stored as plasma (at -80 °C) until later analysis of glucose, insulin, triglycerides, free fatty acids and cholesterol.

Immune function markers

Saliva samples (~1 mL per sample) will be taken twice per participant. These samples will be stored at -80°C until later analysis. Saliva samples will be analysed for salivary IgA and IL-6.

Quality of Life (QoL)

Impact of Weight on Quality of Life (IWQOL)-Lite will be used to assess QoL. It consists of a 31-item, self-report, obesity-specific measure of health-related quality of life comprising of a total score and scores on each of five sub-scales (physical function, self-esteem, sexual life, public distress, and work). The participants will be asked to complete this questionnaire pre- and post- intervention. This questionnaire has been validated by Kolotkin & Crosby (2002).

Profile of Mood States (POMS)

POMS will be used as a measure of affective mood state pre- and post- intervention. The POMS measures six identifiable mood or affective states: 1) Tension-Anxiety 2) Vigour-Activity 3) Depression-Dejection 4) Fatigue-Inertia 5) Anger-Hostility 6) Confusion-Bewilderment.

Training/Mood log

Both the control and the exercise groups will be asked to keep a record of a training/mood log (Ivy et al., 1988). Training/mood log for the exercise group will measure self rated exercise resistance and intensity, Rating of Perceived Exertion (RPE), Felt Arousal States (FAS) and Feeling Scale (FS). Control group will be asked to keep a mood log that will measure FAS.

13 Where will the project be conducted? Include information about the physical location/setting.

B27 and B60, Massey University Albany Campus – Pre- and Post- intervention measurements (all groups).

All Season's Fitness Centre, Howick – spin classes (exercise group only).

14 If the study is based overseas:

i) Specify which countries are involved;

ii) Outline how overseas country requirements (if any) have been complied with;

iii) Have the University's Policy & Procedures for Course Related Student Travel Overseas been met? *(Note: Overseas travel undertaken by students – refer to item 5.10 in the document "Additional Information" on the MUHEC website.)*

15 Describe the experience of the researcher and/or supervisor to undertake this type of project?

Vivian Lee (Masters student) - has over two years experience in conducting and carrying out research projects. A Post graduate study and an undergraduate study has been conducted and completed over two years.

Dr. Ajmol Ali (Chief Supervisor) – has over 15 years experience using human participants in similar studies. Dr Ali has previously supervised 7 MSc and 2 PhD students.

Dr Kay Rutherfurd-Markwick (Co-supervisor) has experience in the planning and running of human trials as well as subsequent sample analysis. Dr Rutherfurd-Markwick has previously supervised 4 MSc and 4 PhD students.

Mr. Simon Bennett (Laboratory Manager) – has over 5 years experience in studies using human participants especially in regards to saliva and blood sampling.

16 Describe the process that has been used to discuss and analyse the ethical issues present in this project.

The Code of Ethical Conduct has been read and discussed amongst the research group and with the project supervisors. Protocols set out by Massey University to obtain ethical clearance have been discussed amongst the research group to ensure they are followed.

Participants

17 Describe the intended participants.

Exercise groups: the intended participants are males and females aged between 30 – 60 years, who participate in regular exercise.

Control group: similar demographics as experimental groups but where participants do not exercise on a regular basis.

18 How many participants will be involved?

60 participants will be recruited for the study.

- 20 will be in the control group where they do not participate in regular activity.
- 20 in the exercise placebo group.
- 20 in the exercise CHO group.

What is the reason for selecting this number?

(Where relevant, attach a copy of the Statistical Justification to the application form)

Sample size was estimated using data from Svendsen et al. (1993), who investigated the effect of exercise and exercise + diet on health and fitness parameters, and an appropriate statistical package (GPower 3.0). A sample size of 16 per group is sufficient to detect 0.8% change in body weight between exercise only and exercise and diet controlled trials, with a power of 0.96 and at a p-value of <0.05. However, to account for participant drop-out, the aim is to recruit 20 participants per group.

19 Describe how potential participants will be identified and recruited?

Potential participants for the exercise group will be recruited from All Season Fitness Centre within the group of people that attend spin classes. A brief speech prior to the start of the classes will be given informing them of the study and they will be asked to pick up an information sheet if they are interested in taking part.

Participants for the control group will be recruited through advertisement around Albany. They will be asked to contact the researcher if they are interested in taking part.

20 Does the project involve recruitment through advertising? **Yes** X **No** ☐

(If yes, attach a copy of the advertisement to the application form)

21 Does the project require permission of an organisation (e.g. an educational institution, an academic unit of Massey University or a business) to access participants or information? **Yes** X **No** ☐

If yes, list the organisation(s).

All Season's Fitness Centre.

(Attach a copy of the draft request letter(s), e.g. letter to Board of Trustees,PVC,HoD/I/S,CEO etc to the application form. Include this in your list of attachments (Q5). Note that some educational institutions may require the researcher to submit a Police Security Clearance.)

22 Who will make the initial approach to potential participants?

The researcher, Vivian Lee.

23 Describe criteria (if used) to select participants from the pool of potential participants.

Experimental group: participants are to be between the ages of 30 and 60, and taking part in 2 - 3 spin classes per week. Individuals reporting any current or previous medical conditions will be excluded from this study. Participants will need to be available for the duration of the study (12-week period).

Control group: similar demographics as experimental groups but where participants do not exercise on a regular basis. Participants will need to be available for pre- and post- intervention testing (2 hours per session, 12 weeks apart).

24 How much time will participants have to give to the project?

The participants will need to come in for pre- and post- measures of 2 hour each and participate in 2 - 3 45-min spin classes per week. This equates to approximately 19 to 26 hours over the 12-week data collection period.

The participants in the control group will need to come in for pre- and post- intervention measures of 2 hour each. This equates to approximately 4 hours over the 12-week data collection period.

Data Collection

25 Does the project include the use of participant questionnaire/s? **Yes** [X] **No** [ ]

(If yes, attach a copy of the Questionnaire/s to the application form and include this in your list of attachments (Q5))

If yes: i) indicate whether the participants will be anonymous (i.e. their identity unknown to the researcher). **Yes** [ ] **No** [X]

ii) describe how the questionnaire will be distributed and collected.

The questionnaire will be filled out when the participants come into the lab for the pre- and post-intervention measures. The distribution and collection of the questionnaire will be conducted at the time of the pre- and post- measures.

(If distributing electronically through Massey IT, attach a copy of the draft request letter to the Director, Information Technology Services to the application form. Include this in your list of attachments (Q5) – refer to the policy on "Research Use of IT Infrastructure".)

26 Does the project involve observation of participants? If yes, please describe. **Yes** [ ] **No** [X]

27 Does the project include the use of focus group/s? **Yes** [ ] **No** [X]

(If yes, attach a copy of the Confidentiality Agreement for the focus group to the application form)

If yes, describe the location of the focus group and time length, including whether it will be in work time. *(If the latter, ensure the researcher asks permission for this from the employer).*

28 Does the project include the use of participant interview/s? **Yes** [ ] **No** [X]

(If yes, attach a copy of the Interview Questions/Schedule to the application form)

If yes, describe the location of the interview and time length, including whether it will be in work time. *(If the latter, ensure the researcher asks permission for this from the employer)*

29 Does the project involve sound recording? **Yes** [ ] **No** [X]

30 Does the project involve image recording, e.g. photo or video? **Yes** [ ] **No** [X]

If yes, please describe. *(If agreement for recording is optional for participation, ensure there is explicit consent on the Consent Form)*

31 If recording is used, will the record be transcribed? **Yes** [ ] **No** [ ]

If yes, state who will do the transcribing.

(If not the researcher, a Transcriber's Confidentiality Agreement is required – attach a copy to the application form. Normally, transcripts of interviews should be provided to participants for editing, therefore an Authority For the Release of Tape Transcripts is required – attach a copy to the application form. However, if the researcher considers that the right of the participant to edit is inappropriate, a justification should be provided below.)

32 Does the project involve any other method of data collection not covered in Qs 25-31? **Yes** [ ] **No** [X]

If yes, describe the method used.

33 Does the project require permission to access databases? **Yes** [ ] **No** [X]

(If yes, attach a copy of the draft request letter/s to the application form. Include this in your list of attachments (Q5). Note: If you wish to access the Massey University student database, written permission from Director, National Student Relations should be attached.)

34 Who will carry out the data collection?

Vivian Lee, Mr. Simon Bennett, Dr. Ajmol Ali and Dr. Kay Rutherfurd-Markwick.

SECTION C: BENEFITS / RISK OF HARM (Refer Code Section 3, Para 10)

35 What are the possible benefits (if any) of the project to individual participants, groups, communities and institutions?

Participants will gain knowledge on their health and fitness.

The result of this study is potentially beneficial to the community in helping reduce obesity and also has the potential to examine the effectiveness of regular spin classes for health and fitness.

36 What discomfort (physical, psychological, social), incapacity or other risk of harm are individual participants likely to experience as a result of participation?

Participants may experience fatigue during pre- and post- measurement of exercise efficiency. They may also feel discomfort during blood and/or saliva sampling.

37 Describe the strategies you will use to deal with any of the situations identified in Q36.

The health screening questionnaire will be used to exclude any participants that are not able to exercise or have any reason that prevents them from exercising. In addition, if they feel uncomfortable, they will not be forced to complete the protocol.

Blood and saliva sampling will be conducted by experienced researchers that are familiar with the protocols.

38 What is the risk of harm (if any) of the project to the researcher?

Potential risk of harm exists for the researchers when performing blood and saliva sampling due to the handling of bodily fluids.

39 Describe the strategies you will use to deal with any of the situations identified in Q38.

The researchers will be experienced in taking blood and saliva samples and the relevant SOPs will be followed throughout the study. Blood and saliva samples will be collected in a designated, enclosed area in B60 and carried out wearing protective gloves. Sharps bins will be available for needle disposal as well as yellow hazards bag for other soft materials.

40 What discomfort (physical, psychological, social) incapacity or other risk of harm are groups/communities and institutions likely to experience as a result of this research?

None

41 Describe the strategies you will use to deal with any of the situations identified in Q40.

N/A

42 Is ethnicity data being collected as part of the project? **Yes** [ ] **No** [X]

If yes, will the data be used as a basis for analysis? If so, justify this use in terms of the number of participants.

If no, justify this approach, given that in some research an analysis based on ethnicity may yield results of value to Maori and to other groups.

Due to the wide variation of ethnic groups within the gym, it is unlikely that significant results would be found from an analysis based on ethnicity.

(Note that harm can be done through an analysis based on insufficient numbers)

43 **If participants are children/students in a pre-school/school/tertiary setting, describe the arrangements you will make for children/students who are present but not taking part in the research.**

(Note that no child/student should be disadvantaged through the research)

N/A

SECTION D: INFORMED & VOLUNTARY CONSENT (Refer Code Section 3, Para 11)

44 **By whom and how, will information about the research be given to potential participants?**

The information will be given out by the researcher in a form of an information sheet. Consent forms will be collected from the participants and all participants will be made aware of their right to withdraw at any time without penalty or having to provide reasons.

45 **Will consent to participate be given in writing?** **Yes** [X] **No** [ ]

(Attach copies of Consent Form/s to the application form)

If no, justify the use of oral consent.

46 **Will participants include persons under the age of 16?** **Yes** [ ] **No** [X]

If yes: i) indicate the age group and competency for giving consent.

ii) indicate if the researcher will be obtaining the consent of parent(s)/caregiver(s). **Yes** [ ] **No** [ ]

(Note that parental/caregiver consent for school-based research may be required by the school even when children are competent. Ensure Information Sheets and Consent Forms are in a style and language appropriate for the age group.)

47 **Will participants include persons whose capacity to give informed consent may be compromised?** **Yes** [ ] **No** [X]

If yes, describe the consent process you will use.

48 **Will the participants be proficient in English?** **Yes** [X] **No** [ ]

If no, all documentation for participants (Information Sheets/Consent Forms/Questionnaire etc) must be translated into the participants' first-language.

(Attach copies of the translated Information Sheet/Consent Form etc to the application form)

SECTION E: PRIVACY/CONFIDENTIALITY ISSUES (Refer Code Section 3, Para 12)

49 **Will any information be obtained from any source other than the participant?** **Yes** [ ] **No** [X]

If yes, describe how and from whom.

50 **Will any information that identifies participants be given to any person outside the research team?** **Yes** [ ] **No** [X]

If yes, indicate why and how.

51 **Will the participants be anonymous (i.e. their identity unknown to the researcher?)** **Yes** [ ] **No** [X]

If no, explain how confidentiality of the participants' identities will be maintained in the treatment and use of the data.

The identity of the participants will only be known to the researcher for the purpose of analysis later on.

52	**Will an institution (e.g. school) to which participants belong be named or be able to be identified?**	**Yes**		**No**	X

If yes, explain how you have made the institution aware of this?

53 Outline how and where:

i) the data will be stored, and

Data will be stored at a secure location at Massey University, Albany Campus.

(Pay particular attention to identifiable data, e.g. tapes, videos and images)

ii) Consent Forms will be stored

These forms will be stored at a secure location, separate from data, at Massey University, Albany Campus.

(Note that Consent Forms should be stored separately from data)

54 i) Who will have access to the data/Consent Forms?

Appropriate staff from the School of Sport and Exercise at Massey University and the researchers of this study will have access to the data/consent forms.

ii) How will the data/Consent Forms be protected from unauthorised access?

They will be locked with authorised access only.

55 How long will the data from the study be kept, who will be responsible for its safe keeping and eventual disposal? (Note that health information relating to an identifiable individual must be retained for at least 10 years, or in the case of a child, 10 years from the age of 16).

(For student research the Massey University HOD Institute/School/Section / Supervisor / or nominee should be responsible for the eventual disposal of data. Note that although destruction is the most common form of disposal, at times, transfer of data to an official archive may be appropriate. Refer to the Code, Section 4, Para 24.)

All data will be stored for 10 years and will be disposed of by an appropriate member from the School of Sport and Exercise.

SECTION F: DECEPTION (Refer Code Section 3, Para 13)

56	**Is deception involved at any stage of the project?**	**Yes**		**No**	X

If yes, justify its use and describe the debriefing procedures.

SECTION G: CONFLICT OF ROLE/INTEREST (Refer Code Section 3, Para 14)

57	**Is the project to be funded in any way from sources external to Massey University?**	**Yes**		**No**	X

If yes: i) state the source.

ii) does the source of the funding present any conflict of interest with regard to the research topic?

58	**Does the researcher/s have a financial interest in the outcome of the project?**	**Yes**		**No**	X

If yes, explain how the conflict of interest situation will be dealt with.

---

59 **Describe any professional or other relationship between the researcher and the participants? (e.g. employer/employee, lecturer/student, practitioner/patient, researcher/family member). Indicate how any resulting conflict of role will be dealt with.**

There is a possibility that the participants may be a student of the Supervisors. If so, they will be informed that their grades will not be affected by their decision to participate or not to participate in this study.

SECTION H: COMPENSATION TO PARTICIPANTS (Refer Code Section 4, Para 23)

60	**Will any payments or other compensation be given to participants?**	**Yes**	X	**No**	

If yes, describe what, how and why.

(Note that compensation (if provided) should be given to all participants and not constitute an inducement. Details of any compensation provided must be included in the Information Sheet.)

Participants will be reimbursed for travel expenses by provision of MTA vouchers ($20 per participant). They will also be provided with breakfast following during the pre- and post- intervention measures prior the cycling protocol.

SECTION I: TREATY OF WAITANGI (Refer Code Section 2)

61	**Are Maori the primary focus of the project?**	**Yes**		**No**	X

If yes: Answer Q62 – 65

If no, outline: i) what Maori involvement there may be, and

There may or may not be people who identify as Maori who volunteer for this project.

ii) how this will be managed.

We have consulted the HRC's "Te Ara Tika Guidelines for Maori Research Ethics: A Framework for Researchers and Ethics Committee Members" document. As there will only be minor Maori participant contemporary or mainstream consultation will be sufficient without the need for any further Maori consultation.

62	**Is the researcher competent in te reo Maori and tikanga Maori?**	**Yes**		**No**	

If no, outline the processes in place for the provision of cultural advice.

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63 **Identify the group/s with whom consultation has taken place or is planned and describe the consultation process.**

(Where consultation has already taken place, attach a copy of the supporting documentation to the application form, e.g. a letter from an iwi authority)

---

64 **Describe any ongoing involvement of the group/s consulted in the project.**

---

65 **Describe how information resulting from the project will be shared with the group/s consulted?**

SECTION J: CULTURAL ISSUES (Refer Code Section 3, Para 15)

66	**Other than those issues covered in Section I, are there any aspects of the project**	**Yes**		**No**	X

that might raise specific cultural issues?

If yes, explain. Otherwise, proceed to Section K.

67 **What ethnic or social group/s (other than Maori) does the project involve?**

68 **Does the researcher speak the language of the target population?** Yes [ ] No [ ]

If no, specify how communication with participants will be managed.

69 **Describe the cultural competence of the researcher for carrying out the project.**

(Note that where the researcher is not a member of the cultural group being researched, a cultural advisor may be necessary)

70 **Identify the group/s with whom consultation has taken place or is planned.**

(Where consultation has already taken place, attach a copy of the supporting documentation to the application form)

71 **Describe any ongoing involvement of the group/s consulted in the project.**

72 **Describe how information resulting from the project will be shared with the group/s consulted.**

73 **If the research is to be conducted overseas, describe the arrangements you will make for local participants to express concerns regarding the research.**

SECTION K: SHARING RESEARCH FINDINGS (Refer Code Section 4, Para 26)

74 **Describe how information resulting from the project will be shared with participants and disseminated in other forums, e.g. peer review, publications, conferences.**

All participants will be given a copy of their fitness and health post- intervention. In addition, the summary of the study will be available to the participants. Summarised results will be kept anonymous. This study will be presented to peers, School of Sport and Exercise staff, and Institute of Food, Nutrition and Human Health staff, and also at a suitable conference. A manuscript will be prepared for publication within an international peer-reviewed journal.

If abnormal results are found in the participant's individual fitness and health assessments, the paticipants will be inform and referred to the appropriate specialist for a proper check-up.As we are not specialists, we cannot make any prognosis.

(Note that receipt of a summary is one of the participant rights)

SECTION L: INVASIVE PROCEDURES/PHYSIOLOGICAL TESTS (Refer Code Section 4, Para 21)

75 **Does the project involve the collection of tissues, blood, other body fluids or physiological tests?** *(If yes, complete Section L, otherwise proceed to Section M)* Yes [X] No [ ]

If yes, are the procedures to be used governed by Standard Operating Procedure(s)? If so, please name the SOP(s). If not, identify the procedure(s) and describe how you will minimise the risks associated with the procedure(s)?

The following guidelines will be adhered to when conducting this study:

Sport Science Laboratory Hygiene and Safety Procedures.

SOP – Collection of saliva specimen

SOP – Collection of blood specimen

76 **Describe the material to be taken and the method used to obtain it. Include information about the training of those taking the samples and the safety of all persons involved. If blood is taken, specify the volume and number of collections.**

Saliva samples (~1 mL per sample) will be taken twice per participant. These sample will be stored at -80°C until later analysis.

Blood samples (~10 mL per sample) will be taken twice per participant (pre- and post- intervention) by venepuncture. Blood samples will be centrifuged and stored as plasma (at -80 °C) until later analysis of glucose, insulin, triglycerides and cholesterol.

Expiratory gas measures will be taken every 3-4 min while doing the 16-min incremental exercise protocol pre- and post- intervention. The expired gas will be collected by the use of Douglas bag method and sample will be analysed by a suitable gas analyser.

Researchers performing the collection will be trained and be familiar with the protocol. They will all be aware of the safety procedures. The samples will be analysed at Massey University Albany Campus.

77 **Will the material be stored?** **Yes** X **No**

If yes, describe how, where and for how long.

Blood and saliva samples will be stored at -80 °C in B60; all samples will undergo analysis at a later date.

78 **Describe how the material will be disposed of (either after the research is completed or at the end of the storage period).**

(Note that the wishes of relevant cultural groups must be taken into account)

The material will be disposed of in a biohazards bin after analysis.

79 **Will material collected for another purpose (e.g. diagnostic use) be used?** **Yes** **No** X

If yes, did the donors give permission for use of their samples in this project? **Yes** **No**
(Attach evidence of this to the application form).

If no, describe how consent will be obtained. Where the samples have been anonymised and consent cannot be obtained, provide justification for the use of these samples.

80 **Will any samples be imported into New Zealand?** **Yes** **No** X

If yes, provide evidence of permission of the donors for their material to be used in this research.

81 **Will any samples go out of New Zealand?** **Yes** **No** X

If yes, state where.

(Note this information must be included in the Information Sheet)

82 **Describe any physiological tests/procedures that will be used.**

The following physiological variables will be measured:

Height, weight, and waist and hip circumference will be measured pre- and post-intervention.

Heart rate will be measured at rest in both control and exercise groups. In the exercise group, heart rate will also be measured during individual exercise session using a Polar heart rate monitor.

Resting blood pressure will be measured using a sphygmomanometer and stethoscope pre- and post-intervention.

Air displacement plethysmography (BodPod) will be used to measure body composition of the participant pre- and post- intervention.

83	**Will participants be given a health-screening test prior to participation?** *(If yes, attach a copy of the health checklist)*	**Yes**	X	**No**	

Reminder: Attach the completed Screening Questionnaire and other attachments listed in Q5

SECTION M: DECLARATION (*Complete appropriate box)*

ACADEMIC STAFF RESEARCH

Declaration for Academic Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this research. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Staff Applicant's Signature .... Date: ....

STUDENT RESEARCH

Declaration for Student Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Supervisor. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

The information contained in this application is to the very best of my knowledge accurate and not misleading.

Student Applicant's Signature .... Date: 24th Feb 2012

Declaration for Supervisor

I have assisted the student in the ethical analysis of this project. As supervisor of this research I will ensure that the research is carried out according to the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

Supervisor's Signature .... Date: 24th Feb 2012

Print Name Ajmol Ali Kay Rutherfurd-Markwick

GENERAL STAFF RESEARCH/EVALUATIONS

Declaration for General Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Line Manager. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. The information contained in this application is to the very best of my knowledge accurate and not misleading.

General Staff Applicant's Signature .... Date: ....

Declaration for Line Manager

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Line Manager's Signature .... Date: ....

Print Name ....

TEACHING PROGRAMME

Declaration for Paper Controller

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the teaching programme as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this teaching programme. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Paper Controller's Signature .... Date: ....

Declaration for Head of Department/School/Institute

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Head of Dept/School/Inst Signature .... Date: ....

Print Name ....

Appendix 10

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Training and Monitoring log

“Happy Carb study”

ID number: ________________________

This diary is designed to record your training and activation/arousal levels over the period of the study.

All information provided in this dairy will be treated with the strictest confidence. No outside parties will have access to any information.

Thank you for participating in this study. Your time is much appreciated!

Vivian Lee
Phone: 021 164 7325
Happycarbstudy@gmail.com

Random fact of the week:

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Instructions

Exercise

Training:

Please specify if you've attended an RPM class today. If 'no' please skip to the 'perception' section.

Resistance:

Please specify the resistance you chose for your exercise session

1. Low resistance
2. Moderate resistance
3. High resistance

Intensity:

Please specify the intensity (how hard you worked) during the exercise session.

1. Low intensity
2. Moderate intensity
3. High intensity

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Ratings of Perceived Exertion (RPE):

During each exercise bout we want you to pay close attention to how hard you feel the exercise work rate is. This feeling should reflect your total amount of exertion and fatigue, combining all sensations of physical stress, effort, and fatigue. Don't concern yourself with any one factor (e.g. leg pain, shortness of breath) but try to concentrate on your total inner feeling of exertion. Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can.

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

Feeling Scale (FS):

This is the Feeling Scale. While participating in exercise it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas others find it to be unpleasurable. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise. Scientists have developed this scale to measure such responses. Please state the FS for your exercise session.

+5	Very good
+4	
+3	Good
+2	
+1	Fairly good
0	Neutral
-1	Fairly bad
-2	
-3	Bad
-4	
-5	Very bad

Perception

Felt Arousal Scale (FAS):

This scale measures how 'worked up' or aroused you feel. You might experience high arousal in one of a variety of ways, for example as anxiety or anger. Low arousal might also be experienced by you in a number of different ways, for example as relaxation or boredom or calmness. Please state your FAS for your exercise session.

1	Low arousal
2	
3	
4	
5	
6	High arousal

Wellness log

Please record your daily health status. If you have no health problems, tick the nil box and you don't need to record the rest. If you have upper respiratory symptoms (URS) please indicate the type of symptoms by rating the severity

Severity

0 = not applicable

1 = very mild, no change to daily training

2 = mild, affected daily training

3 = moderate, did not train today

4 = severe, confined to bed

Medication

Please specify if you've taken any medications for the symptoms stated above

Other

Please state the type of medications taken if so, and write down any general comments for the day.

Profile of mood status (POMS)

Please follow the instructions and fill this out at the end of each week.

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Week ___

		Example		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
	Exercise	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Exercise	Intensity	2															
	Resistance	1															
	RPE	13															
Perception	FAS	4															
	FS	2															
Wellness	Nil	0															
	Coughing	1															
	Headache	1															
	Nasal symptoms	0															
	Sore throat	1															
	Diarrhoea	0															
	Any medications?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	Other	Took aspirins Training was as normal															

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This is the POMS questionnaire. Please fill this out once at the end of each week ☺

Profile of Mood States (POMS)

DATE ____________________ TIME ____________________ DAY ____________________

Consider how you are feeling right now, when CIRCLING the appropriate response beside each item.
Please check to make sure you have responded to all the items.

FATIGUE	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Worn Out	0	1	2	3	4
Weary	0	1	2	3	4
Bushed	0	1	2	3	4
Fatigued	0	1	2	3	4
Exhausted	0	1	2	3	4

ANGER	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Peeved	0	1	2	3	4
Bitter	0	1	2	3	4
Resentful	0	1	2	3	4
Grouchy	0	1	2	3	4
Angry	0	1	2	3	4
Furious	0	1	2	3	4
Annoyed	0	1	2	3	4

VIGOR	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Cheerful	0	1	2	3	4
Powerful	0	1	2	3	4
Full of Pep	0	1	2	3	4
Active	0	1	2	3	4
Energetic	0	1	2	3	4
Lively	0	1	2	3	4

TENSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Restless	0	1	2	3	4
Nervous	0	1	2	3	4
On-edge	0	1	2	3	4
Tense	0	1	2	3	4
Uneasy	0	1	2	3	4
Anxious	0	1	2	3	4

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ESTEEM	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Embarrassed	0	1	2	3	4
Ashamed	0	1	2	3	4
Proud	0	1	2	3	4
Competent	0	1	2	3	4
Satisfied	0	1	2	3	4

CONFUSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Bewildered	0	1	2	3	4
Forgetful	0	1	2	3	4
Confused	0	1	2	3	4
Unable to concentrate	0	1	2	3	4
Uncertain about things	0	1	2	3	4

DEPRESSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Hopeless	0	1	2	3	4
Helpless	0	1	2	3	4
Sad	0	1	2	3	4
Worthless	0	1	2	3	4
Miserable	0	1	2	3	4
Discouraged	0	1	2	3	4

Grove, J.R., Prapavessis, H. Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *International Journal of Sport Psychology*. 1992 Apr-Jun Vol 23(2) 93-109.
SHONA L. HALSON,1,2 MATTHEW W. BRIDGE,1 ROMAIN MEEUSEN,3 BART BUSSCHAERT,3 MICHAEL GLEESON,1 DAVID A. JONES,1 AND ASKER E. JEUKENDRUP1 Time course of performance changes and fatigue markers during intensified training in trained cyclists. *J Appl Physiol 93: 947–956, 2002.*
Morgan WP, Brown DR, Raglin JS, O'Connor PJ, and Ellickson KA. Psychological monitoring of overtraining and staleness. Br J Sports Med 21: 107–114, 1987.

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Health Screening Questionnaire

Name:____

Address: ____

Phone: _______________________________

Age: ________________

Gender:________________.

Please read the following questions carefully. If you have any difficulty, please advise the medical practitioner, nurse or exercise specialist who is conducting the exercise test.

Please answer all of the following questions by ticking only <u>one</u> box for each question:

The questions are based upon the Physical Activity Readiness Questionnaire (PAR-Q), originally devised by the British Columbia Dept of Health (Canada), as revised by [1]Thomas *et al.* (1992) and [2]Cardinal *et al.* (1996), and with added requirements of the Massey University Human Ethics Committee. The information provided by you on this form will be treated with the strictest confidentiality.

Qu 1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?

Yes ☐ No ☐

Qu 2. Do you feel a pain in your chest when you do physical activity?

Yes ☐ No ☐

Qu 3. In the past month have you had chest pain when you were not doing physical activity?

Yes ☐ No ☐

Qu 4. Do you lose your balance because of dizziness or do you ever lose consciousness?

Yes ☐ No ☐

Qu 5. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

Yes ☐ No ☐

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Qu 6. Have you been hospitalised recently?

Yes ☐ No ☐

Qu 7. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?

Yes ☐ No ☐

Qu 8. Do you have a blood borne infectious disease?

Yes ☐ No ☐

Qu 9. Do you have any respiratory problems that could be made worse by a change in your physical activity?

Yes ☐ No ☐

Qu 10. Do you have any skin disorders?

Yes ☐ No ☐

Qu 11. Have you ever had hypercholesterolaemia?

Yes ☐ No ☐

Qu 12. Do you have diabetes?

Yes ☐ No ☐

I have read, understood and completed this questionnaire.

Signature: ____ Date: ___________________

References

1. Thomas S, Reading J and Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can J Sport Sci* 17(4): 338-345.
2. Cardinal BJ, Esters J and Cardinal MK. Evaluation of the revised physical activity readiness questionnaire in older adults. *Med Sci Sports Exerc* 28(4): 468-472

Impact of Weight on Quality of Life Questionnaire—Lite Version (IWQOL-Lite)

Please answer the following statements by circling the number that best applies to you in the past week. Be as open as possible. There are no right or wrong answers.

Physical Function		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I have trouble picking up objects.	5	4	3	2	1
2.	Because of my weight I have trouble tying my shoes.	5	4	3	2	1
3.	Because of my weight I have difficulty getting up from chairs.	5	4	3	2	1
4.	Because of my weight I have trouble using stairs.	5	4	3	2	1
5.	Because of my weight I have difficulty putting on or taking off my clothing.	5	4	3	2	1
6.	Because of my weight I have trouble with mobility.	5	4	3	2	1
7.	Because of my weight I have trouble crossing my legs.	5	4	3	2	1
8.	I feel short of breath with only mild exertion.	5	4	3	2	1
9.	I am troubled by painful or stiff joints.	5	4	3	2	1
10.	My ankles and lower legs are swollen at the end of the day.	5	4	3	2	1
11.	I am worried about my health.	5	4	3	2	1
Self-esteem		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I am self-conscious.	5	4	3	2	1
2.	Because of my weight my self-esteem is not what it could be.	5	4	3	2	1
3.	Because of my weight I feel unsure of myself.	5	4	3	2	1
4.	Because of my weight I don’t like myself.	5	4	3	2	1
5.	Because of my weight I am afraid of being rejected.	5	4	3	2	1
6.	Because of my weight I avoid looking in mirrors or seeing myself in photographs.	5	4	3	2	1
7.	Because of my weight I am embarrassed to be seen in public places.	5	4	3	2	1

Sexual Life		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I do not enjoy sexual activity.	5	4	3	2	1
2.	Because of my weight I have little or no sexual desire.	5	4	3	2	1
3.	Because of my weight I have difficulty with sexual performance.	5	4	3	2	1
4.	Because of my weight I avoid sexual encounters whenever possible.	5	4	3	2	1

Public Distress		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I experience ridicule, teasing, or unwanted attention.	5	4	3	2	1
2.	Because of my weight I worry about fitting into seats in public places (e.g. theaters, restaurants, cars, or airplanes).	5	4	3	2	1
3.	Because of my weight I worry about fitting through aisles or turnstiles.	5	4	3	2	1
4.	Because of my weight I worry about finding chairs that are strong enough to hold my weight.	5	4	3	2	1
5.	Because of my weight I experience discrimination by others.	5	4	3	2	1
Work (Note: For homemakers and retirees, answer with respect to your daily activities.)		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I have trouble getting things accomplished or meeting my responsibilities.	5	4	3	2	1
2.	Because of my weight I am less productive than I could be.	5	4	3	2	1
3.	Because of my weight I don't receive appropriate raises, promotions or recognition at work.	5	4	3	2	1
4.	Because of my weight I am afraid to go on job interviews.	5	4	3	2	1

Appendix 13

During the exercise bout we want you to pay close attention to how hard you feel the exercise work rate is.
This feeling should reflect your total amount of exertion and fatigue, combining all sensations of physical stress, effort, and fatigue.

Don’t concern yourself with any one factor (e.g. leg pain, shortness of breath) but try to concentrate on your total inner feeling of exertion.

Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can.

RPE SCALE

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

While participating in exercise it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas other find it to be unpleasurable.

Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise.

Scientists have developed this scale to measure such responses.

FEELING SCALE

+5	Very good
+4	
+3	Good
+2	
+1	Fairly good
0	Neutral
-1	Fairly bad
-2	
-3	Bad
-4	
-5	Very bad

This scale measures how ‘worked up’ or aroused you feel.

You might experience high arousal in one of a variety of ways, for example as anxiety or anger.

Low arousal might also be experienced by you in a number of different ways, for example as relaxation or boredom or calmness.

FELT AROUSAL SCALE

1	Low arousal
2	
3	
4	
5	
6	High arousal

Appendix 16

Post-intervention Questionnaire

1. What is your first name?

2. What is your last name?

3. Would you normally eat something prior to attending the RPM class?

    Yes/No

4. Do you normally take carbohydrate drinks during RPM classes?

    Yes/No

5. You were put in either the carbohydrate-drink group or the placebo group. Which group do you think you were in?

    a. Carbohydrate-drink group

    b. Placebo group

    c. Don't know

6. How was the drink taken?

    a. Large volume, less frequently throughout the RPM class (less than 3 sips)

    b. Moderate volume, moderately frequent throughout the RPM class (3 to 5 sips)

    c. Small volume, frequently throughout the RPM class (more than 5 sips)

    d. other (Please specify)

7. How did you feel about the drink?

Appendix 17

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24th February 2012

To the directors of All Season's Fitness Centre

My name is Vivian Lee and I am a Masters student at Massey University. I am currently looking to conduct a study that requires approximately 40 participants that attend the RPM classes that you provide. The study will be examining the effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood in recreational exercisers between the ages of 30 to 60. Carbohydrate is a well-known ergogenic aid and is also known to improve immune function, affect mood and perceived exertion. Studies on elite athletes examining the influence of carbohydrate ingestion during acute exercise (single sessions) are abundant however studies on recreational exercisers are lacking. Therefore, this study will be using male and female recreational exercisers between the ages of 30 to 60, who attend 2-3 RPM classes per week. The participants will have the opportunity to assess their fitness levels, and also experience air displacement plethysmography (commonly known as BodPod), state-of-the art equipment that measures body composition.

The study also looks to assess the effectiveness of regular attendance of RPM classes for 10 weeks. This may form positive publicity for the classes which your gym may benefit from. I would really like the opportunity to work with the members of your gym as I am also a member that enjoys your facilities.

Please do not hesitate to contact me if you have any queries regarding this study.

Yours faithfully,

Vivian Lee

dpwlek@hotmail.com

0211647325

Appendix 1

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Effect of carbohydrate ingestion during exercise on health, fitness, quality of Life and mood

PARTICIPANT INFORMATION SHEET (Intervention group)

Invitation to Participate in Research Study

We, Ms. Vivian Lee, Dr. Ali and Dr. Rutherfurd-Markwick are researchers at Massey University and are currently conducting a study examining the effects of carbohydrate intake during exercise on health, fitness, mood and quality of life. This is a study for a Master's Degree at Massey University. Carbohydrate is known to be a performance enhancing ergogenic aid and is an important macronutrient in energy provision during exercise, as well as being the only fuel for the central nervous system. Consequently carbohydrate has also been shown to enhance mood and improve fatigue. This in turn leads us to the possibility of utilizing carbohydrate as an exercise-enhancing supplement during exercise to improve health, fitness, quality of life and mood.

Participant Recruitment

We are looking for 40 participants between the ages of 30 to 60 to participate in this study. To participate in the study you will need to be attending 2 - 3 RPM classes per week.

You will be informed verbally of the aims, procedures and demands and any potential risks and discomfort that the study will entail. Written consent will then be obtained from you; please note that you will still retain the right to withdraw from the study, without reason, at any stage.

You will be asked to complete a general health-screening questionnaire before taking part in any aspects of this study. Individuals reporting any current or previous medical conditions indicated in this form will be excluded from the study.

Project Procedures and Participant Involvement

Participants will firstly be screened for their eligibility for this study.

You will initially undergo pre-intervention testing which will include measuring anthropometrics (height, weight, hip and waist circumference) and body composition, resting blood pressure and heart rate, collection of blood and saliva, and a fitness test. Each intervention testing will take approximately 1.5-2 hours. Body composition will be measured using air displacement plethysmography (BodPod) and resting blood pressure and heart rate will be measured with appropriate equipment. BodPod is the latest state-of-the art equipment that uses air displacement plethysmography to measure body composition. Blood (venepuncture) and saliva sample will be collected once pre- and post- intervention to analyse metabolic (glucose, insulin, cholesterol and free-fatty acids) and immune function. The fitness test consists of a 16-minute incremental cycling test using a cycle ergometer. The exercise intensity increases every 4 minutes and between those times, variables (heart rate and expired gas analysis via the use of Douglus bags) will be measured to assess your fitness level. You will also be asked to complete two questionnaires, Quality of Life Questionnaire and Profile of Mood Questionnaire (POMS).

During the 10-week intervention, you will be randomized into either a placebo group or an experimental group. The drink will consist of 3ml/kg of your body mass and will be provided prior to each exercise session to be taken during the session. Following the pre-intervention testing, all participants will be given a training/monitoring log to be completed after each exercise session. This will be used to record your exercise intensity and other perceptual variables. Each exercise session will consist of the 45-min RPM classes that you normally attend.

Post-intervention will consist of the tests carried out in the pre-intervention testing.

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All participants will be given a copy of their health and fitness post- intervention. In addition, the summary of the study will be available to the participants. If any abnormal results are found during the analysis, we will inform you of the findings and refer you an appropriate specialist for a formal check-up.

Participant's Rights
You are under no obligation to accept this invitation. Should you choose to participate, you have the right to:
- decline to answer any particular question
- withdraw from the study at any time, even after signing a consent form (if you choose to withdraw you cannot withdraw your data from the analysis after the data collection has been completed)
- ask any questions about the study at any time during participation
- provide information on the understanding that your name will not be used unless you give permission to the researcher
- be given access to a summary of the project findings when it is concluded

Confidentiality
All data collected will be used solely for research purposes and has the possibility of being presented in a professional journal. All personal information will be kept confidential by assigning numbers to each participant. No names will be visible on any papers on which you provide information. All data/information will be dealt with in confidentiality and will be stored in a secure location for five years on the Massey University Albany campus. After this time it will be disposed of by an appropriate staff member from the School of Sport and Exercise and/or Institute of Food, Nutrition, and Human Health.

Project Contacts
If you have any questions regarding this study, please do not hesitate to contact either of the following people for assistance:

Researchers: Vivian Lee (School of Sport and Exercise, Massey University),
021 164 7325; happycarbstudy@gmail.com

Supervisor: Dr. Ajmol Ali (School of Sport and Exercise, Massey University)
(09)414-0800 ext.41184; a.ali@massey.ac.nz

Dr. Kay Rutherfurd-Markwick (IFNHH, Massey University)
(09) 414-0800 ext. 41141; k.j.rutherfurd@massey.ac.nz

Committee Approval Statement
This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 12/06. If you have any concerns about the conduct of this research, please contact A/Prof Hugh Morton, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 350 5799 x 4265, email humanethicsoutha@massey.ac.nz.

Compensation for Injury
If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Injury Prevention, Rehabilitation and Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury. If your ACC claim is not accepted you should immediately contact the researcher. The

researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

Appendix 2

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Are you curious about your fitness level or your body composition?

Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who exercise regularly, to join our study.

The participants will be participating in a 10-week exercise intervention study comparing the effect of carbohydrate drink in measuring health, fitness, quality of life and mood. All the selected participants will be asked to come in twice, separated by a 10-week period to measure their body composition, and other health and fitness parameters.

For a chance to measure your body composition with the latest state-of-the art equipment, and also for a chance to measure your health and fitness parameters, please contact Vivian by phone or e-mail!

Phone: 021 164 7325

Email: happycarbstudy@gmail.com

Appendix 3

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Are you curious about your body composition? Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who do not participate in regular exercise, to join our study.

For a chance to measure your body composition with the latest state-of-the art equipment, please contact Vivian by phone or e-mail!

Phone: 021 164 7325
Email: happycarbstudy@gmail.com

Appendix 4

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Are you curious about your body composition?

Would you like to find out?

We are looking for potential participants between the ages of 30 – 60, who do not participate in regular exercise, to join our study in measuring body composition.

The participants are required to act as the control group for a study that requires an exercising group and a non-exercising group. The exercising group will be participating in a 10-week exercise intervention study comparing the effects of carbohydrate drink on health, fitness, quality of life and mood. All the selected participants will be asked to come in twice, separated by a 10-week period to measure their body composition, and other health and fitness parameters.

For a chance to measure your body composition with the latest state-of-the art equipment, please contact Vivian by phone or e-mail!

Phone: 021 164 7325

Email: happycarbstudy@gmail.com

School of Sport & Exercise
Private Bag 102904, North Shore City 0745, New Zealand T +64 9 414 0800 **www.massey.ac.nz**

Appendix 5

MASSEY UNIVERSITY
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TE WĀHANGA PŪTAIAO

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

PARTICIPANT INFORMATION SHEET (Control group)

Invitation to Participate in Research Study

We, Ms. Vivian Lee, Dr. Ali and Dr. Rutherfurd-Markwick are researchers at Massey University and are currently conducting a study examining the effects of carbohydrate ingestion during exercise on health, fitness, mood and quality of life. This is a study for a Master's Degree at Massey University. A well designed study requires a control group that acts as the baseline of all measurements. Hence, we are looking to recruit participants to take part in the control group for this study. Potential participants will enjoy the opportunity to assess their health and fitness parameters as well as their mood and quality of life.

Participant Recruitment

We are looking for 20 participants between the ages of 30 to 60 to participate in this study. To participate in the study you will not be taking part in any regular exercise.

You will be informed verbally of the aims, procedures and demands and any potential risks and discomfort that the study will entail. Written consent will then be obtained from you; please note that you will still retain the right to withdraw from the study, without reason, at any stage.
You will be asked to complete a general health-screening questionnaire before taking part in any aspects of this study. Individuals reporting any current or previous medical conditions indicated in this form will be excluded from the study.

Project Procedures and Participant Involvement

Participants will firstly be screened for their eligibility for this study.

You will initially undergo pre-intervention testing which will include measuring anthropometrics (height, weight, hip and waist circumference) and body composition, resting blood pressure and heart rate, collection of blood and saliva, and a fitness test. Each intervention testing will take approximately 1.5-2 hours. Body composition will be measured using air displacement plethysmography (BodPod) and resting blood pressure and heart rate will be measured with appropriate equipment. BodPod is the latest state-of-the art equipment that uses air displacement plethysmography to measure body composition. Blood (venepuncture) and saliva sample will be collected once pre- and post- intervention to analyse metabolic (glucose, insulin, cholesterol and free-fatty acids) and immune function (). The fitness test consists of a 16-minute incremental cycling test using a cycle ergometer. The exercise intensity increases every 4 minutes and between those times, variables (heart rate and expired gas analysis via the use of Douglus bags) will be measured to assess your fitness level. You will also be asked to complete two questionnaires, Quality of Life Questionnaire and Profile of Mood Questionnaire (POMS). During the 10-week intervention period you will be asked to record your activation/arousal measures in a logbook. Following this period you will be asked to come back to the laboratory for post-intervention measures.

All participants will be given a copy of their health and fitness post- intervention. In addition, the summary of the study will be available to the participants. If any abnormal results are found during the analysis, we will inform you of the findings and refer you an appropriate specialist for a formal check-up.

Participant's Rights

You are under no obligation to accept this invitation. Should you choose to participate, you have the right to:
• decline to answer any particular question
• withdraw from the study at any time, even after signing a consent form (if you choose to withdraw you cannot withdraw your data from the analysis after the data collection has been completed)

• ask any questions about the study at any time during participation
• provide information on the understanding that your name will not be used unless you give permission to the researcher
• be given access to a summary of the project findings when it is concluded

Confidentiality
All data collected will be used solely for research purposes and has the possibility of being presented in a professional journal. All personal information will be kept confidential by assigning numbers to each participant. No names will be visible on any papers on which you provide information. All data/information will be dealt with in confidentiality and will be stored in a secure location for five years on the Massey University Albany campus. After this time it will be disposed of by an appropriate staff member from the School of Sport and Exercise and/or Institute of Food, Nutrition, and Human Health.

Project Contacts
If you have any questions regarding this study, please do not hesitate to contact either of the following people for assistance:

Researchers: Vivian Lee (School of Sport and Exercise, Massey University),
021 164 7325; happycarbstudy@gmail.com

Supervisor: Dr. Ajmol Ali (School of Sport and Exercise, Massey University)
(09)414-0800 ext.41184; a.ali@massey.ac.nz

Dr. Kay Rutherfurd-Markwick (IFNHH, Massey University)
(09) 414-0800 ext. 41141; k.j.rutherfurd@massey.ac.nz

Committee Approval Statement
This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 12/06. If you have any concerns about the conduct of this research, please contact A/Prof Hugh Morton, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 350 5799 x 4265, email humanethicsoutha@massey.ac.nz.

Compensation for Injury
If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Injury Prevention, Rehabilitation and Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury. If your ACC claim is not accepted you should immediately contact the researcher. The researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

Appendix 6

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Screening Questionnaire (Intervention Group)

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Thank you for your interest in this study. We need to ask you a few questions to make sure you are suitable for this study. To participate in this study, you need to be between 30 – 60 years of age and attend at least 2 – 3 RPM classes per week for 10 weeks.

Name: ______________________________ Participant ID: __________________

Date of Birth: _______/______/______(DD/MM/YY)

Sex: Male/ Female

Phone number: ______________________________

Address: ____

E-mail: ____

What is the best way of contacting you? *(Please circle most appropriate answer)*

Post / e-mail / telephone

Are you proficient in English?

Yes / No

Do you attend at least 2-3 RPM classes per week?

Yes / No

Will you be continuously attending the RPM classes for the next 4 months?

Yes / No

Are you able to come in to Massey University Albany Campus twice, separated by approximately 10 weeks?

Yes / No

Thank you for your time☺.

Appendix 7

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Screening Questionnaire (Control Group)

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Thank you for your interest in this study. We need to ask you a few questions to make sure you are suitable for this study. To participate in this study, you need to be between 30 – 60 years of age and do not participant in regular activity.

Name: ________________________________ Participant ID: ___________________

Date of Birth: _______/______/______(DD/MM/YY)

Sex: Male/ Female

Phone number: _______________________________

Address: ____

E-mail: ____

What is the best way of contacting you? *(Please circle most appropriate answer)*

Post / e-mail / telephone

Are you proficient in English?

Yes / No

Do you participate in regular activity (this includes going to the gym or playing recreational sports)?

Yes / No

Are you able to come in to Massey University Albany Campus twice, separated by approximately 10 weeks?

Yes / No

Thank you for your time☺.

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

CONSENT FORM FOR STUDY VOLUNTEERS

This consent form will be held for a minimum period of five (5) years

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I understand that I have the right to withdraw from the study at any time and to decline to answer any particular questions.

I agree to provide information to the researcher on the understanding that my name will not be used without my permission. (The information will be used only for this research and publications arising from this research project).

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: ____ **Date**___________________

Full Name (printed)

____

Phone Number______________________ **Age** _______________ **Date of Birth** _________

Participant code ☐

Te Kunenga ki Pūrehuroa

School of Sport & Exercise
Private Bag 102904, North Shore City 0745, New Zealand T +64 9 414 0800 www.massey.ac.nz

Appendix 9

Massey University
Te Kunenga ki Pūrehuroa

Application No: _____ / ___________
This number is assigned when your application is accepted.
Quote on all documentation to participants and the Committee.

Human Ethics Application

FOR APPROVAL OF PROPOSED RESEARCH/TEACHING/EVALUATION
INVOLVING HUMAN PARTICIPANTS
(All applications are to be typed and presented using language that is free from jargon and comprehensible to lay people)

SECTION A

1 Project Title Effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood

Projected start date for data collection April 2012 **Projected end date** March **2013**

(In no case will approval be given if recruitment and/or data collection has already begun).

2 Applicant Details *(Select the appropriate box and complete details)*

ACADEMIC STAFF APPLICATION (excluding staff who are also students)

Full Name of Staff Applicant/s

School/Department/Institute

Campus *(mark one only)* **Albany** [ ] **Palmerston North** [ ] **Wellington** [ ]

Telephone **Email Address**

STUDENT APPLICATION

Full Name of Student Applicant Vivian Ye Jee Lee

Employer (if applicable)

Telephone 0211647325 **Email Address** dpwlek@hotmail.com

Postal Address 5 Alicia Road Howick, Auckland 2014, New Zealand

Full Name of Supervisor(s) Dr Ajmol Ali and Dr Kay Rutherfurd-Markwick

School/Department/Institute School of Sport and Exercise, IFNHH

Campus *(mark one only)* **Albany** [X] **Palmerston North** [ ] **Wellington** [ ]

Telephone **Email Address**
Ext 41184, 41141 a.ali@massey.ac.nz, k.j.rutherfurd@massey.ac.nz

GENERAL STAFF APPLICATION

Full Name of Applicant

Section

Campus *(mark one only)* **Albany** [ ] **Palmerston North** [ ] **Wellington** [ ]

Telephone **Email Address**

Full Name of Line Manager

Section

Telephone **Email Address**

3 Type of Project *(provide detail as appropriate)*

Staff Research/Evaluation:		Student Research:		If other, please specify:
Academic Staff		**Specify Qualification**	**MSc**	
General Staff		**Specify Credit Value of Research**	**120**	
Evaluation		**(e.g. 30, 60, 90, 120, 240, 360)**		

4 Summary of Project

Please outline in no more than 200 words in lay language why you have chosen this project, what you intend to do and the methods you will use.

(Note: All the information provided in the application is potentially available if a request is made under the Official Information Act. In the event that a request is made, the University, in the first instance, would endeavour to satisfy that request by providing this summary. Please ensure that the language used is comprehensible to all.)

Carbohydrate (CHO) intake, especially 'sugary' sports drinks, is perceived to be detrimental for health and weight management (Bray et al., 2004). However, CHO is an important macronutrient for energy provision during exercise (El-Sayed et al., 1997), as well as fuel for the central nervous system (Ivy, 1999). Therefore, CHO intake is a well known performance-enhancing ergogenic aid (Hulston and Jeukendrup, 2009). In addition, CHO is also known to influence mood (Benton & Owens, 1993) and lead to more pleasurable feelings during exercise (Backhouse et al., 2007).

' Spin' classes are becoming increasingly popular group-fitness cycling sessions where participants work at self-selected exercise intensities. CHO supplements may allow these recreational exercisers to increase energy expenditure during exercise, enhance their 'affect', mood and improve health and fitness parameters.

Therefore, this study will examine the influence of CHO intake during 2-3 x 45-min spin classes per week, over a 10-week intervention period, on health and fitness parameters in recreational exercisers. Participants will be randomly allocated to experimental (7% CHO solutions; 3 ml/kg body mass per exercise session) or placebo (0% CHO taste- and volume-matched solutions) groups. A further control group (age and gender-matched) will be recruited to examine the effect of exercise (spin classes) alone on health and fitness parameters. Body composition (BodPod), cardiovascular fitness (cycling test), anthropometric measures, metabolic (blood sample) and immune (saliva sample) markers, mood state and quality of life (questionnaires) will be measured pre- and post-intervention in all participants.

5 List the Attachments to your Application, e.g. Completed "Screening Questionnaire to Determine the Approval Procedure" (compulsory), Information Sheet/s *(indicate how many)*, Translated copies of Information Sheet/s, Consent Form/s *(indicate of how many)*, Translated copies of Consent Form/s, Transcriber Confidentiality Agreement, Confidentiality Agreement *(for persons other than the researcher / participants who have access to project data)*, Authority for Release of Tape Transcripts, Advertisement, Health Checklist, Questionnaire, Interview Schedule, Evidence of Consultation, Letter requesting access to an institution, Letter requesting approval for use of database, Other *(please specify)*.

Screening Questionnaire
Information Sheet (Control and Exercise group)
Consent form
Training/Mood log (Control and Exercise group)
Health Screening Questionnaire
Advertising Poster
Quality of Life Questionnaire
Profile of Moods State (POMS) Questionnaire
Feeling Scale (FS)
Felt Arousal Scale (FAS)
Ratings of Perceived Exertion (RPE) scale
Letter to recruit participants

Applications that are incomplete or lacking the appropriate signatures will not be processed. This will mean delays for the project.

Please refer to the Human Ethics website (http://humanethics.massey.ac.nz) for details of where to submit your application and the number of copies required.

SECTION B: PROJECT INFORMATION

General

6 **I/We wish the protocol to be heard in a closed meeting (Part II).** **Yes** [ ] **No** [X]

(If yes, state the reason in a covering letter.)

7 **Does this project have any links to previously submitted MUHEC or HDEC application(s)?** **Yes** [X] **No** [ ]

If yes, list the MUHEC or HDEC application number/s (if assigned) and relationship/s.

MUHEC Southern A: 07/025 VO_2 peak test performed on a cycle ergometer and also the use of various perceptual scales (e.g. RPE, FS, FAS, and POMS) to assess mood and perceived exertion during such exercise.

MUHEC Southern A: 10/86 – Blood sampling for metabolic markers, including the use of perceptual scales (e.g. RPE, FS, FAS, POMS) to assess mood and perceived exertion during exercise.

MUHEC Southern a: 11/86 –Saliva sampling conducted on exercising participants to measure concentration of electrolytes, protein, salivary enzyme and immunoglobulin-A.

8 **Is approval from other Ethics Committees being sought for the project?** **Yes** [ ] **No** [X]

If yes, list the other Ethics Committees.

9 **For staff research, is the applicant the only researcher?** **Yes** [ ] **No** [ ]

If no, list the names and addresses of all members of the research team.

Project Details

10 **State concisely the aims of the project.**

The primary aim of this study is to examine the effect of CHO ingestion during a 10-week exercise regime on health and fitness parameters, mood and quality of life in recreational exercisers. A second aim is to examine the effect of 10 weeks of spin classes on health and fitness parameters.

11 **Give a brief background to the project to place it in perspective and to allow the project's significance to be assessed.** *(No more than 200 words in lay language)*

'Sugary' CHO drinks are found to be detrimental in health and weight management (Bray et al., 2004). However CHO is an important macronutrient for energy provision to the muscle as well as being the only fuel for the central nervous system (CNS). 'Acute' studies (single exercise sessions) with CHO ingestion during exercise using elite athletes show improved exercise performance (Nicolas et al., 1995), pleasurable feelings (Backhouse et al., 2007), and improvements in immune function (Bishop et al., 1999). However, there are no studies examining the effects of CHO ingestion during multiple exercise sessions on recreational exercisers.

Fitness classes are commonly enjoyed by recreational exercisers and 'spin' classes are fast becoming one of the most enjoyed fitness classes. Spin classes are taken by taught instructors and, with the use of spin bikes, the exercise intensity and resistance are self-adjustable.

CHO ingestion during exercise has been shown to increase work rate (El-Sayed et al., 1996) and hence, if provided during exercise, may lead to an increase in exercise intensity. Continual exercise (over multiple sessions) at a higher work rate may in turn improve health and fitness parameters. Thus the primary aim of this study is to examine the effect of CHO ingestion during a 10-week exercise regime on health and fitness parameters, mood, and quality of life in recreational exercisers. The secondary aim is to examine the effect of 10 weeks of spin classes on health and fitness parameters.

12 Outline the research procedures to be used, including approach/procedures for collecting data. Use a flow chart if necessary.

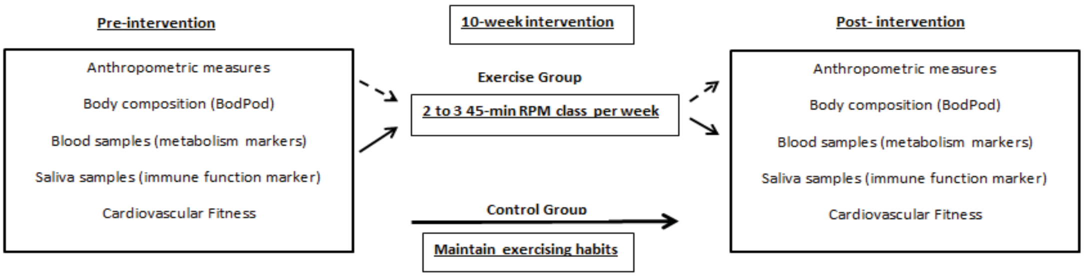

Figure 1. Outline of the intervention measures. In the exercise group, full line represents the placebo group and the dotted line represents the CHO group.

Participants will be asked to come into the laboratory following an overnight fast (only water allowed) for pre-intervention measurements (Figure 1). For the exercise groups participants will be randomly selected (stratified by age and gender) into CHO and placebo groups. In the CHO trial participants will be asked to consume 3 ml/kg body mass per exercise session (2-3 times/week) of a 7% CHO solution during the 10-week intervention period. In the placebo trial participants will be asked to consume 3 ml/kg body mass taste-matched 0% CHO solution during exercise. The control group will be asked to maintain their normal dietary and exercise habits during the 10-week intervention period. All participants will then return for the post-intervention measurements (Figure 1). The 10-week intervention for the exercise group will consist of 2 - 3 spin 45-min spin classes per week.

Anthropometric measures

Participant's height, weight, and hip and waste circumference will be measured pre- and post- intervention.

Heart rate

Resting heart rate in both control and exercise groups will be measured pre- and post- intervention. In the exercise group, heart rate will also be measured during individual exercise session using the Team Polar heart rate monitor.

Blood Pressure

Resting blood pressure will be measured using a sphygmomanometer and stethoscope pre- and post- intervention in both control and exercise group.

Cardiovascular fitness

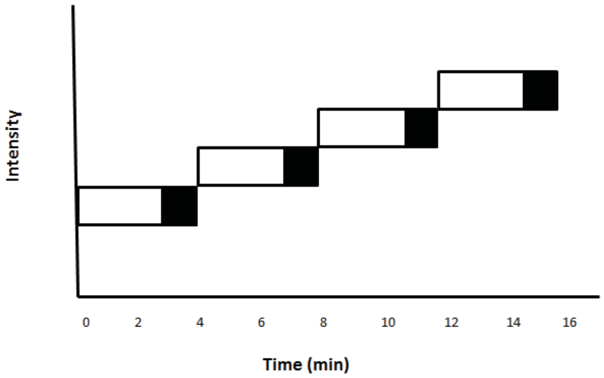

Figure 2. The 16-min incremental cycling protocol. Every 4th minute, RPE and expired air will be collected.

The participants will perform a 16-min incremental cycling protocol (Figure 2) to assess their cardiovascular and cardiorespiratory fitness levels by examining the relationship between a) work rate and heart rate, b) work rate and ventilation rate and c) work rate and oxygen uptake. This requires the participant to cycle at 60 rpm continuously for 16 minutes on an electromagnetically-braked cycle ergometer with increasing exercise intensities. Expired air and RPE will be collected every 4th minute and analysed to estimate exercise efficiency. Heart rate will be continuously measured with a Polar heart rate monitor. The Astrand-Rhyming (Astrand & Rhyming, 1954) method will be utilized to estimate maximal oxygen uptake (VO_2max).

Metabolism markers

Blood samples (~10 mL per sample) will be taken twice per participant (pre- and post- intervention) via venepuncture. Blood samples will be centrifuged and stored as plasma (at -80 °C) until later analysis of glucose, insulin, triglycerides, free fatty acids and cholesterol.

Immune function markers

Saliva samples (~1 mL per sample) will be taken twice per participant. These samples will be stored at -80°C until later analysis. Saliva samples will be analysed for salivary IgA and IL-6.

Quality of Life (QoL)

Impact of Weight on Quality of Life (IWQOL)-Lite will be used to assess QoL. It consists of a 31-item, self-report, obesity-specific measure of health-related quality of life comprising of a total score and scores on each of five sub-scales (physical function, self-esteem, sexual life, public distress, and work). The participants will be asked to complete this questionnaire pre- and post- intervention. This questionnaire has been validated by Kolotkin & Crosby (2002).

Profile of Mood States (POMS)

POMS will be used as a measure of affective mood state pre- and post- intervention. The POMS measures six identifiable mood or affective states: 1) Tension-Anxiety 2) Vigour-Activity 3) Depression-Dejection 4) Fatigue-Inertia 5) Anger-Hostility 6) Confusion-Bewilderment.

Training/Mood log

Both the control and the exercise groups will be asked to keep a record of a training/mood log (Ivy et al., 1988). Training/mood log for the exercise group will measure self rated exercise resistance and intensity, Rating of Perceived Exertion (RPE), Felt Arousal States (FAS) and Feeling Scale (FS). Control group will be asked to keep a mood log that will measure FAS.

13 Where will the project be conducted? Include information about the physical location/setting.

B27 and B60, Massey University Albany Campus – Pre- and Post- intervention measurements (all groups).

All Season's Fitness Centre, Howick – spin classes (exercise group only).

14 If the study is based overseas:

i) Specify which countries are involved;

ii) Outline how overseas country requirements (if any) have been complied with;

iii) Have the University's Policy & Procedures for Course Related Student Travel Overseas been met? *(Note: Overseas travel undertaken by students – refer to item 5.10 in the document "Additional Information" on the MUHEC website.)*

15 Describe the experience of the researcher and/or supervisor to undertake this type of project?

Vivian Lee (Masters student) - has over two years experience in conducting and carrying out research projects. A Post graduate study and an undergraduate study has been conducted and completed over two years.

Dr. Ajmol Ali (Chief Supervisor) – has over 15 years experience using human participants in similar studies. Dr Ali has previously supervised 7 MSc and 2 PhD students.

Dr Kay Rutherfurd-Markwick (Co-supervisor) has experience in the planning and running of human trials as well as subsequent sample analysis. Dr Rutherfurd-Markwick has previously supervised 4 MSc and 4 PhD students.

Mr. Simon Bennett (Laboratory Manager) – has over 5 years experience in studies using human participants especially in regards to saliva and blood sampling.

16 Describe the process that has been used to discuss and analyse the ethical issues present in this project.

The Code of Ethical Conduct has been read and discussed amongst the research group and with the project supervisors. Protocols set out by Massey University to obtain ethical clearance have been discussed amongst the research group to ensure they are followed.

Participants

17 Describe the intended participants.

Exercise groups: the intended participants are males and females aged between 30 – 60 years, who participate in regular exercise.

Control group: similar demographics as experimental groups but where participants do not exercise on a regular basis.

18 How many participants will be involved?

60 participants will be recruited for the study.

- 20 will be in the control group where they do not participate in regular activity.
- 20 in the exercise placebo group.
- 20 in the exercise CHO group.

What is the reason for selecting this number?

(Where relevant, attach a copy of the Statistical Justification to the application form)

Sample size was estimated using data from Svendsen et al. (1993), who investigated the effect of exercise and exercise + diet on health and fitness parameters, and an appropriate statistical package (GPower 3.0). A sample size of 16 per group is sufficient to detect 0.8% change in body weight between exercise only and exercise and diet controlled trials, with a power of 0.96 and at a p-value of <0.05. However, to account for participant drop-out, the aim is to recruit 20 participants per group.

19 Describe how potential participants will be identified and recruited?

Potential participants for the exercise group will be recruited from All Season Fitness Centre within the group of people that attend spin classes. A brief speech prior to the start of the classes will be given informing them of the study and they will be asked to pick up an information sheet if they are interested in taking part.

Participants for the control group will be recruited through advertisement around Albany. They will be asked to contact the researcher if they are interested in taking part.

20 Does the project involve recruitment through advertising? **Yes** [X] **No** [ ]

(If yes, attach a copy of the advertisement to the application form)

21 Does the project require permission of an organisation (e.g. an educational institution, an academic unit of Massey University or a business) to access participants or information? **Yes** [X] **No** [ ]

If yes, list the organisation(s).

All Season's Fitness Centre.

(Attach a copy of the draft request letter(s), e.g. letter to Board of Trustees,PVC,HoD/I/S,CEO etc to the application form. Include this in your list of attachments (Q5). Note that some educational institutions may require the researcher to submit a Police Security Clearance.)

22 Who will make the initial approach to potential participants?

The researcher, Vivian Lee.

23 Describe criteria (if used) to select participants from the pool of potential participants.

Experimental group: participants are to be between the ages of 30 and 60, and taking part in 2 - 3 spin classes per week. Individuals reporting any current or previous medical conditions will be excluded from this study. Participants will need to be available for the duration of the study (12-week period).

Control group: similar demographics as experimental groups but where participants do not exercise on a regular basis. Participants will need to be available for pre- and post- intervention testing (2 hours per session, 12 weeks apart).

24 How much time will participants have to give to the project?

The participants will need to come in for pre- and post- measures of 2 hour each and participate in 2 - 3 45-min spin classes per week. This equates to approximately 19 to 26 hours over the 12-week data collection period.

The participants in the control group will need to come in for pre- and post- intervention measures of 2 hour each. This equates to approximately 4 hours over the 12-week data collection period.

Data Collection

25 Does the project include the use of participant questionnaire/s? **Yes** [X] **No** [ ]

(If yes, attach a copy of the Questionnaire/s to the application form and include this in your list of attachments (Q5))

If yes: i) indicate whether the participants will be anonymous (i.e. their identity unknown to the researcher). **Yes** [ ] **No** [X]

ii) describe how the questionnaire will be distributed and collected.

The questionnaire will be filled out when the participants come into the lab for the pre- and post-intervention measures. The distribution and collection of the questionnaire will be conducted at the time of the pre- and post- measures.

(If distributing electronically through Massey IT, attach a copy of the draft request letter to the Director, Information Technology Services to the application form. Include this in your list of attachments (Q5) – refer to the policy on "Research Use of IT Infrastructure".)

26 Does the project involve observation of participants? If yes, please describe. **Yes** [ ] **No** [X]

27 Does the project include the use of focus group/s? **Yes** [ ] **No** [X]

(If yes, attach a copy of the Confidentiality Agreement for the focus group to the application form)

If yes, describe the location of the focus group and time length, including whether it will be in work time. *(If the latter, ensure the researcher asks permission for this from the employer).*

28 Does the project include the use of participant interview/s? **Yes** [ ] **No** [X]

(If yes, attach a copy of the Interview Questions/Schedule to the application form)

If yes, describe the location of the interview and time length, including whether it will be in work time. *(If the latter, ensure the researcher asks permission for this from the employer)*

29 Does the project involve sound recording? **Yes** [ ] **No** [X]

30 Does the project involve image recording, e.g. photo or video? **Yes** [ ] **No** [X]

If yes, please describe. *(If agreement for recording is optional for participation, ensure there is explicit consent on the Consent Form)*

31 If recording is used, will the record be transcribed? **Yes** [ ] **No** [ ]

If yes, state who will do the transcribing.

(If not the researcher, a Transcriber's Confidentiality Agreement is required – attach a copy to the application form. Normally, transcripts of interviews should be provided to participants for editing, therefore an Authority For the Release of Tape Transcripts is required – attach a copy to the application form. However, if the researcher considers that the right of the participant to edit is inappropriate, a justification should be provided below.)

32 Does the project involve any other method of data collection not covered in Qs 25-31? **Yes** [ ] **No** [X]

If yes, describe the method used.

33	**Does the project require permission to access databases?**	**Yes**		**No**	X

(If yes, attach a copy of the draft request letter/s to the application form. Include this in your list of attachments (Q5). Note: If you wish to access the Massey University student database, written permission from Director, National Student Relations should be attached.)

34 Who will carry out the data collection?

Vivian Lee, Mr. Simon Bennett, Dr. Ajmol Ali and Dr. Kay Rutherfurd-Markwick.

SECTION C: BENEFITS / RISK OF HARM (Refer Code Section 3, Para 10)

35 What are the possible benefits (if any) of the project to individual participants, groups, communities and institutions?

Participants will gain knowledge on their health and fitness.

The result of this study is potentially beneficial to the community in helping reduce obesity and also has the potential to examine the effectiveness of regular spin classes for health and fitness.

36 What discomfort (physical, psychological, social), incapacity or other risk of harm are individual participants likely to experience as a result of participation?

Participants may experience fatigue during pre- and post- measurement of exercise efficiency. They may also feel discomfort during blood and/or saliva sampling.

37 Describe the strategies you will use to deal with any of the situations identified in Q36.

The health screening questionnaire will be used to exclude any participants that are not able to exercise or have any reason that prevents them from exercising. In addition, if they feel uncomfortable, they will not be forced to complete the protocol.

Blood and saliva sampling will be conducted by experienced researchers that are familiar with the protocols.

38 What is the risk of harm (if any) of the project to the researcher?

Potential risk of harm exists for the researchers when performing blood and saliva sampling due to the handling of bodily fluids.

39 Describe the strategies you will use to deal with any of the situations identified in Q38.

The researchers will be experienced in taking blood and saliva samples and the relevant SOPs will be followed throughout the study. Blood and saliva samples will be collected in a designated, enclosed area in B60 and carried out wearing protective gloves. Sharps bins will be available for needle disposal as well as yellow hazards bag for other soft materials.

40 What discomfort (physical, psychological, social) incapacity or other risk of harm are groups/communities and institutions likely to experience as a result of this research?

None

41 Describe the strategies you will use to deal with any of the situations identified in Q40.

N/A

42	**Is ethnicity data being collected as part of the project?**	**Yes**		**No**	X

If yes, will the data be used as a basis for analysis? If so, justify this use in terms of the number of participants.

If no, justify this approach, given that in some research an analysis based on ethnicity may yield results of value to Maori and to other groups.

Due to the wide variation of ethnic groups within the gym, it is unlikely that significant results would be found from an analysis based on ethnicity.

(Note that harm can be done through an analysis based on insufficient numbers)

43 **If participants are children/students in a pre-school/school/tertiary setting, describe the arrangements you will make for children/students who are present but not taking part in the research.**

(Note that no child/student should be disadvantaged through the research)

N/A

SECTION D: INFORMED & VOLUNTARY CONSENT (Refer Code Section 3, Para 11)

44 **By whom and how, will information about the research be given to potential participants?**

The information will be given out by the researcher in a form of an information sheet. Consent forms will be collected from the participants and all participants will be made aware of their right to withdraw at any time without penalty or having to provide reasons.

45 **Will consent to participate be given in writing?** **Yes** [X] **No** [ ]

(Attach copies of Consent Form/s to the application form)

If no, justify the use of oral consent.

46 **Will participants include persons under the age of 16?** **Yes** [ ] **No** [X]

If yes: i) indicate the age group and competency for giving consent.

ii) indicate if the researcher will be obtaining the consent of parent(s)/caregiver(s). **Yes** [ ] **No** [ ]

(Note that parental/caregiver consent for school-based research may be required by the school even when children are competent. Ensure Information Sheets and Consent Forms are in a style and language appropriate for the age group.)

47 **Will participants include persons whose capacity to give informed consent may be compromised?** **Yes** [ ] **No** [X]

If yes, describe the consent process you will use.

48 **Will the participants be proficient in English?** **Yes** [X] **No** [ ]

If no, all documentation for participants (Information Sheets/Consent Forms/Questionnaire etc) must be translated into the participants' first-language.

(Attach copies of the translated Information Sheet/Consent Form etc to the application form)

SECTION E: PRIVACY/CONFIDENTIALITY ISSUES (Refer Code Section 3, Para 12)

49 **Will any information be obtained from any source other than the participant?** **Yes** [ ] **No** [X]

If yes, describe how and from whom.

50 **Will any information that identifies participants be given to any person outside the research team?** **Yes** [ ] **No** [X]

If yes, indicate why and how.

51 **Will the participants be anonymous (i.e. their identity unknown to the researcher?)** **Yes** [ ] **No** [X]

If no, explain how confidentiality of the participants' identities will be maintained in the treatment and use of the data.

The identity of the participants will only be known to the researcher for the purpose of analysis later on.

52	**Will an institution (e.g. school) to which participants belong be named or be able to be identified?**	**Yes**		**No**	X

If yes, explain how you have made the institution aware of this?

53 **Outline how and where:**

i) the data will be stored, and

Data will be stored at a secure location at Massey University, Albany Campus.

(Pay particular attention to identifiable data, e.g. tapes, videos and images)

ii) Consent Forms will be stored

These forms will be stored at a secure location, separate from data, at Massey University, Albany Campus.

(Note that Consent Forms should be stored separately from data)

54 **i) Who will have access to the data/Consent Forms?**

Appropriate staff from the School of Sport and Exercise at Massey University and the researchers of this study will have access to the data/consent forms.

ii) How will the data/Consent Forms be protected from unauthorised access?

They will be locked with authorised access only.

55 **How long will the data from the study be kept, who will be responsible for its safe keeping and eventual disposal? (Note that health information relating to an identifiable individual must be retained for at least 10 years, or in the case of a child, 10 years from the age of 16).**

(For student research the Massey University HOD Institute/School/Section / Supervisor / or nominee should be responsible for the eventual disposal of data. Note that although destruction is the most common form of disposal, at times, transfer of data to an official archive may be appropriate. Refer to the Code, Section 4, Para 24.)

All data will be stored for 10 years and will be disposed of by an appropriate member from the School of Sport and Exercise.

SECTION F: DECEPTION (Refer Code Section 3, Para 13)

56	**Is deception involved at any stage of the project?**	**Yes**		**No**	X

If yes, justify its use and describe the debriefing procedures.

SECTION G: CONFLICT OF ROLE/INTEREST (Refer Code Section 3, Para 14)

57	**Is the project to be funded in any way from sources external to Massey University?**	**Yes**		**No**	X

If yes: i) state the source.

ii) does the source of the funding present any conflict of interest with regard to the research topic?

58 **Does the researcher/s have a financial interest in the outcome of the project?** **Yes** [ ] **No** [X]

If yes, explain how the conflict of interest situation will be dealt with.

59 **Describe any professional or other relationship between the researcher and the participants? (e.g. employer/employee, lecturer/student, practitioner/patient, researcher/family member). Indicate how any resulting conflict of role will be dealt with.**

There is a possibility that the participants may be a student of the Supervisors. If so, they will be informed that their grades will not be affected by their decision to participate or not to participate in this study.

SECTION H: COMPENSATION TO PARTICIPANTS (Refer Code Section 4, Para 23)

60 **Will any payments or other compensation be given to participants?** **Yes** [X] **No** [ ]

If yes, describe what, how and why.

(Note that compensation (if provided) should be given to all participants and not constitute an inducement. Details of any compensation provided must be included in the Information Sheet.)

Participants will be reimbursed for travel expenses by provision of MTA vouchers ($20 per participant). They will also be provided with breakfast following during the pre- and post- intervention measures prior the cycling protocol.

SECTION I: TREATY OF WAITANGI (Refer Code Section 2)

61 **Are Maori the primary focus of the project?** **Yes** [ ] **No** [X]

If yes: Answer Q62 – 65

If no, outline: i) what Maori involvement there may be, and

There may or may not be people who identify as Maori who volunteer for this project.

ii) how this will be managed.

We have consulted the HRC's "Te Ara Tika Guidelines for Maori Research Ethics: A Framework for Researchers and Ethics Committee Members" document. As there will only be minor Maori participant contemporary or mainstream consultation will be sufficient without the need for any further Maori consultation.

62 **Is the researcher competent in te reo Maori and tikanga Maori?** **Yes** [ ] **No** [ ]

If no, outline the processes in place for the provision of cultural advice.

63 **Identify the group/s with whom consultation has taken place or is planned and describe the consultation process.**

(Where consultation has already taken place, attach a copy of the supporting documentation to the application form, e.g. a letter from an iwi authority)

64 **Describe any ongoing involvement of the group/s consulted in the project.**

65 **Describe how information resulting from the project will be shared with the group/s consulted?**

SECTION J: CULTURAL ISSUES (Refer Code Section 3, Para 15)

66 **Other than those issues covered in Section I, are there any aspects of the project** **Yes** [ ] **No** [X] that might raise specific cultural issues?

If yes, explain. Otherwise, proceed to Section K.

67 What ethnic or social group/s (other than Maori) does the project involve?

68 Does the researcher speak the language of the target population? **Yes** ☐ **No** ☐

If no, specify how communication with participants will be managed.

69 Describe the cultural competence of the researcher for carrying out the project.

(Note that where the researcher is not a member of the cultural group being researched, a cultural advisor may be necessary)

70 Identify the group/s with whom consultation has taken place or is planned.

(Where consultation has already taken place, attach a copy of the supporting documentation to the application form)

71 Describe any ongoing involvement of the group/s consulted in the project.

72 Describe how information resulting from the project will be shared with the group/s consulted.

73 If the research is to be conducted overseas, describe the arrangements you will make for local participants to express concerns regarding the research.

SECTION K: SHARING RESEARCH FINDINGS (Refer Code Section 4, Para 26)

74 Describe how information resulting from the project will be shared with participants and disseminated in other forums, e.g. peer review, publications, conferences.

All participants will be given a copy of their fitness and health post- intervention. In addition, the summary of the study will be available to the participants. Summarised results will be kept anonymous. This study will be presented to peers, School of Sport and Exercise staff, and Institute of Food, Nutrition and Human Health staff, and also at a suitable conference. A manuscript will be prepared for publication within an international peer-reviewed journal.

If abnormal results are found in the participant's individual fitness and health assessments, the paticipants will be inform and referred to the appropriate specialist for a proper check-up.As we are not specialists, we cannot make any prognosis.

(Note that receipt of a summary is one of the participant rights)

SECTION L: INVASIVE PROCEDURES/PHYSIOLOGICAL TESTS (Refer Code Section 4, Para 21)

75 Does the project involve the collection of tissues, blood, other body fluids or physiological tests? *(If yes, complete Section L, otherwise proceed to Section M)* **Yes** X **No** ☐

If yes, are the procedures to be used governed by Standard Operating Procedure(s)? If so, please name the SOP(s). If not, identify the procedure(s) and describe how you will minimise the risks associated with the procedure(s)?

The following guidelines will be adhered to when conducting this study:

Sport Science Laboratory Hygiene and Safety Procedures.

SOP – Collection of saliva specimen

SOP – Collection of blood specimen

76 Describe the material to be taken and the method used to obtain it. Include information about the training of those taking the samples and the safety of all persons involved. If blood is taken, specify the volume and number of collections.

Saliva samples (~1 mL per sample) will be taken twice per participant. These sample will be stored at -80°C until later analysis.

Blood samples (~10 mL per sample) will be taken twice per participant (pre- and post- intervention) by venepuncture. Blood samples will be centrifuged and stored as plasma (at -80 °C) until later analysis of glucose, insulin, triglycerides and cholesterol.

Expiratory gas measures will be taken every 3-4 min while doing the 16-min incremental exercise protocol pre- and post- intervention. The expired gas will be collected by the use of Douglas bag method and sample will be analysed by a suitable gas analyser.

Researchers performing the collection will be trained and be familiar with the protocol. They will all be aware of the safety procedures. The samples will be analysed at Massey University Albany Campus.

77 Will the material be stored? **Yes** X **No** ☐

If yes, describe how, where and for how long.

Blood and saliva samples will be stored at -80 °C in B60; all samples will undergo analysis at a later date.

78 Describe how the material will be disposed of (either after the research is completed or at the end of the storage period).

(Note that the wishes of relevant cultural groups must be taken into account)

The material will be disposed of in a biohazards bin after analysis.

79 Will material collected for another purpose (e.g. diagnostic use) be used? **Yes** ☐ **No** X

If yes, did the donors give permission for use of their samples in this project? **Yes** ☐ **No** ☐ *(Attach evidence of this to the application form).*

If no, describe how consent will be obtained. Where the samples have been anonymised and consent cannot be obtained, provide justification for the use of these samples.

80 Will any samples be imported into New Zealand? **Yes** ☐ **No** X

If yes, provide evidence of permission of the donors for their material to be used in this research.

81 Will any samples go out of New Zealand? **Yes** ☐ **No** X

If yes, state where.

(Note this information must be included in the Information Sheet)

82 Describe any physiological tests/procedures that will be used.

The following physiological variables will be measured:

Height, weight, and waist and hip circumference will be measured pre- and post-intervention.

Heart rate will be measured at rest in both control and exercise groups. In the exercise group, heart rate will also be measured during individual exercise session using a Polar heart rate monitor.

Resting blood pressure will be measured using a sphygmomanometer and stethoscope pre- and post-intervention.

Air displacement plethysmography (BodPod) will be used to measure body composition of the participant pre- and post- intervention.

83	**Will participants be given a health-screening test prior to participation?** *(If yes, attach a copy of the health checklist)*	**Yes**	X	**No**	

Reminder: Attach the completed Screening Questionnaire and other attachments listed in Q5

SECTION M: DECLARATION (*Complete appropriate box)*

ACADEMIC STAFF RESEARCH

Declaration for Academic Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this research. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Staff Applicant's Signature .... Date: ....

STUDENT RESEARCH

Declaration for Student Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Supervisor. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

The information contained in this application is to the very best of my knowledge accurate and not misleading.

Student Applicant's Signature  Date: 24th Feb 2012

Declaration for Supervisor

I have assisted the student in the ethical analysis of this project. As supervisor of this research I will ensure that the research is carried out according to the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

Supervisor's Signature  Date: 24th Feb 2012

Print Name Ajmol Ali Kay Rutherfurd-Markwick

GENERAL STAFF RESEARCH/EVALUATIONS

Declaration for General Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Line Manager. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. The information contained in this application is to the very best of my knowledge accurate and not misleading.

General Staff Applicant's Signature .... Date: ....

Declaration for Line Manager

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Line Manager's Signature .... Date: ....

Print Name ....

TEACHING PROGRAMME

Declaration for Paper Controller

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the teaching programme as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this teaching programme. The information contained in this application is to the very best of my knowledge accurate and not misleading.

Paper Controller's Signature .... Date: ....

Declaration for Head of Department/School/Institute

I declare that to the best of my knowledge, this application complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Head of Dept/School/Inst Signature .... Date: ....

Print Name ....

Appendix 10

MASSEY UNIVERSITY
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TE WĀHANGA PŪTAIAO

Training and Monitoring log

"Happy Carb study"

ID number: ________________________

This diary is designed to record your training and activation/arousal levels over the period of the study.

All information provided in this dairy will be treated with the strictest confidence. No outside parties will have access to any information.

Thank you for participating in this study. Your time is much appreciated!

Vivian Lee
Phone: 021 164 7325
Happycarbstudy@gmail.com

Random fact of the week:

Instructions

Exercise

Training:

Please specify if you've attended an RPM class today. If 'no' please skip to the 'perception' section.

Resistance:

Please specify the resistance you chose for your exercise session

1. Low resistance
2. Moderate resistance
3. High resistance

Intensity:

Please specify the intensity (how hard you worked) during the exercise session.

1. Low intensity
2. Moderate intensity
3. High intensity

Ratings of Perceived Exertion (RPE):

During each exercise bout we want you to pay close attention to how hard you feel the exercise work rate is. This feeling should reflect your total amount of exertion and fatigue, combining all sensations of physical stress, effort, and fatigue. Don't concern yourself with any one factor (e.g. leg pain, shortness of breath) but try to concentrate on your total inner feeling of exertion. Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can.

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

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Feeling Scale (FS):

This is the Feeling Scale. While participating in exercise it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas others find it to be unpleasurable. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise. Scientists have developed this scale to measure such responses. Please state the FS for your exercise session.

+5	Very good
+4	
+3	Good
+2	
+1	Fairly good
0	Neutral
-1	Fairly bad
-2	
-3	Bad
-4	
-5	Very bad

Perception

Felt Arousal Scale (FAS):

This scale measures how 'worked up' or aroused you feel. You might experience high arousal in one of a variety of ways, for example as anxiety or anger. Low arousal might also be experienced by you in a number of different ways, for example as relaxation or boredom or calmness. Please state your FAS for your exercise session.

1	Low arousal
2	
3	
4	
5	
6	High arousal

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Wellness log

Please record your daily health status. If you have no health problems, tick the nil box and you don't need to record the rest. If you have upper respiratory symptoms (URS) please indicate the type of symptoms by rating the severity

Severity

0 = not applicable

1 = very mild, no change to daily training

2 = mild, affected daily training

3 = moderate, did not train today

4 = severe, confined to bed

Medication

Please specify if you've taken any medications for the symptoms stated above

Other

Please state the type of medications taken if so, and write down any general comments for the day.

Profile of mood status (POMS)

Please follow the instructions and fill this out at the end of each week.

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Week ___

		Example		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
	Exercise	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Exercise	Intensity	2															
	Resistance	1															
	RPE	13															
Perception	FAS	4															
	FS	2															
Wellness	Nil	0															
	Coughing	1															
	Headache	1															
	Nasal symptoms	0															
	Sore throat	1															
	Diarrhoea	0															
	Any medications?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	Other	Took aspirins Training was as normal															

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This is the POMS questionnaire. Please fill this out once at the end of each week ☺

Profile of Mood States (POMS)

DATE ____________________ TIME ____________________ DAY ____________________

Consider how you are feeling right now, when CIRCLING the appropriate response beside each item. Please check to make sure you have responded to all the items.

FATIGUE	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Worn Out	0	1	2	3	4
Weary	0	1	2	3	4
Bushed	0	1	2	3	4
Fatigued	0	1	2	3	4
Exhausted	0	1	2	3	4

ANGER	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Peeved	0	1	2	3	4
Bitter	0	1	2	3	4
Resentful	0	1	2	3	4
Grouchy	0	1	2	3	4
Angry	0	1	2	3	4
Furious	0	1	2	3	4
Annoyed	0	1	2	3	4

VIGOR	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Cheerful	0	1	2	3	4
Powerful	0	1	2	3	4
Full of Pep	0	1	2	3	4
Active	0	1	2	3	4
Energetic	0	1	2	3	4
Lively	0	1	2	3	4

TENSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Restless	0	1	2	3	4
Nervous	0	1	2	3	4
On-edge	0	1	2	3	4
Tense	0	1	2	3	4
Uneasy	0	1	2	3	4
Anxious	0	1	2	3	4

Te Kunenga ki Pūrehuroa

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ESTEEM	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Embarrassed	0	1	2	3	4
Ashamed	0	1	2	3	4
Proud	0	1	2	3	4
Competent	0	1	2	3	4
Satisfied	0	1	2	3	4

CONFUSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Bewildered	0	1	2	3	4
Forgetful	0	1	2	3	4
Confused	0	1	2	3	4
Unable to concentrate	0	1	2	3	4
Uncertain about things	0	1	2	3	4

DEPRESSION	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
Hopeless	0	1	2	3	4
Helpless	0	1	2	3	4
Sad	0	1	2	3	4
Worthless	0	1	2	3	4
Miserable	0	1	2	3	4
Discouraged	0	1	2	3	4

Grove, J.R., Prapavessis, H. Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *International Journal of Sport Psychology*. 1992 Apr-Jun Vol 23(2) 93-109.
SHONA L. HALSON,1,2 MATTHEW W. BRIDGE,1 ROMAIN MEEUSEN,3 BART BUSSCHAERT,3 MICHAEL GLEESON,1 DAVID A. JONES,1 AND ASKER E. JEUKENDRUP1 Time course of performance changes and fatigue markers during intensified training in trained cyclists. *J Appl Physiol 93: 947–956, 2002.*
Morgan WP, Brown DR, Raglin JS, O'Connor PJ, and Ellickson KA. Psychological monitoring of overtraining and staleness. Br J Sports Med 21: 107–114, 1987.

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Appendix 11

MASSEY UNIVERSITY
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TE WĀHANGA PŪTAIAO

Health Screening Questionnaire

Name:____

Address: ____

Phone: ____________________________

Age: ______________

Gender:______________.

Please read the following questions carefully. If you have any difficulty, please advise the medical practitioner, nurse or exercise specialist who is conducting the exercise test.

Please answer all of the following questions by ticking only one box for each question:

The questions are based upon the Physical Activity Readiness Questionnaire (PAR-Q), originally devised by the British Columbia Dept of Health (Canada), as revised by [1]Thomas *et al.* (1992) and [2]Cardinal *et al.* (1996), and with added requirements of the Massey University Human Ethics Committee. The information provided by you on this form will be treated with the strictest confidentiality.

Qu 1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?

Yes ☐ No ☐

Qu 2. Do you feel a pain in your chest when you do physical activity?

Yes ☐ No ☐

Qu 3. In the past month have you had chest pain when you were not doing physical activity?

Yes ☐ No ☐

Qu 4. Do you lose your balance because of dizziness or do you ever lose consciousness?

Yes ☐ No ☐

Qu 5. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

Yes ☐ No ☐

Qu 6. Have you been hospitalised recently?

Yes ☐ No ☐

Qu 7. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?

Yes ☐ No ☐

Qu 8. Do you have a blood borne infectious disease?

Yes ☐ No ☐

Qu 9. Do you have any respiratory problems that could be made worse by a change in your physical activity?

Yes ☐ No ☐

Qu 10. Do you have any skin disorders?

Yes ☐ No ☐

Qu 11. Have you ever had hypercholesterolaemia?

Yes ☐ No ☐

Qu 12. Do you have diabetes?

Yes ☐ No ☐

I have read, understood and completed this questionnaire.

Signature: ____ Date: ___________________

References

1. Thomas S, Reading J and Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can J Sport Sci* 17(4): 338-345.
2. Cardinal BJ, Esters J and Cardinal MK. Evaluation of the revised physical activity readiness questionnaire in older adults. *Med Sci Sports Exerc* 28(4): 468-472

Impact of Weight on Quality of Life Questionnaire—Lite Version (IWQOL-Lite)

Please answer the following statements by circling the number that best applies to you <u>in the past week</u>. Be as open as possible. There are no right or wrong answers.

Physical Function		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I have trouble picking up objects.	5	4	3	2	1
2.	Because of my weight I have trouble tying my shoes.	5	4	3	2	1
3.	Because of my weight I have difficulty getting up from chairs.	5	4	3	2	1
4.	Because of my weight I have trouble using stairs.	5	4	3	2	1
5.	Because of my weight I have difficulty putting on or taking off my clothing.	5	4	3	2	1
6.	Because of my weight I have trouble with mobility.	5	4	3	2	1
7.	Because of my weight I have trouble crossing my legs.	5	4	3	2	1
8.	I feel short of breath with only mild exertion.	5	4	3	2	1
9.	I am troubled by painful or stiff joints.	5	4	3	2	1
10.	My ankles and lower legs are swollen at the end of the day.	5	4	3	2	1
11.	I am worried about my health.	5	4	3	2	1
Self-esteem		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I am self-conscious.	5	4	3	2	1
2.	Because of my weight my self-esteem is not what it could be.	5	4	3	2	1
3.	Because of my weight I feel unsure of myself.	5	4	3	2	1
4.	Because of my weight I don’t like myself.	5	4	3	2	1
5.	Because of my weight I am afraid of being rejected.	5	4	3	2	1
6.	Because of my weight I avoid looking in mirrors or seeing myself in photographs.	5	4	3	2	1
7.	Because of my weight I am embarrassed to be seen in public places.	5	4	3	2	1

Sexual Life		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I do not enjoy sexual activity.	5	4	3	2	1
2.	Because of my weight I have little or no sexual desire.	5	4	3	2	1
3.	Because of my weight I have difficulty with sexual performance.	5	4	3	2	1
4.	Because of my weight I avoid sexual encounters whenever possible.	5	4	3	2	1

Public Distress		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I experience ridicule, teasing, or unwanted attention.	5	4	3	2	1
2.	Because of my weight I worry about fitting into seats in public places (e.g. theaters, restaurants, cars, or airplanes).	5	4	3	2	1
3.	Because of my weight I worry about fitting through aisles or turnstiles.	5	4	3	2	1
4.	Because of my weight I worry about finding chairs that are strong enough to hold my weight.	5	4	3	2	1
5.	Because of my weight I experience discrimination by others.	5	4	3	2	1
Work (Note: For homemakers and retirees, answer with respect to your daily activities.)		ALWAYS TRUE	USUALLY TRUE	SOMETIMES TRUE	RARELY TRUE	NEVER TRUE
1.	Because of my weight I have trouble getting things accomplished or meeting my responsibilities.	5	4	3	2	1
2.	Because of my weight I am less productive than I could be.	5	4	3	2	1
3.	Because of my weight I don’t receive appropriate raises, promotions or recognition at work.	5	4	3	2	1
4.	Because of my weight I am afraid to go on job interviews.	5	4	3	2	1

Appendix 13

During the exercise bout we want you to pay close attention to how hard you feel the exercise work rate is.
This feeling should reflect your total amount of exertion and fatigue, combining all sensations of physical stress, effort, and fatigue.

Don’t concern yourself with any one factor (e.g. leg pain, shortness of breath) but try to concentrate on your total inner feeling of exertion.

Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can.

RPE SCALE

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

While participating in exercise it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas other find it to be unpleasurable.

Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise.

Scientists have developed this scale to measure such responses.

FEELING SCALE

+5	Very good
+4	
+3	Good
+2	
+1	Fairly good
0	Neutral
-1	Fairly bad
-2	
-3	Bad
-4	
-5	Very bad

This scale measures how ‘worked up’ or aroused you feel.

You might experience high arousal in one of a variety of ways, for example as anxiety or anger.

Low arousal might also be experienced by you in a number of different ways, for example as relaxation or boredom or calmness.

FELT AROUSAL SCALE

1	Low arousal
2	
3	
4	
5	
6	High arousal

Appendix 16

Post-intervention Questionnaire

1. What is your first name?

2. What is your last name?

3. Would you normally eat something prior to attending the RPM class?

    Yes/No

4. Do you normally take carbohydrate drinks during RPM classes?

    Yes/No

5. You were put in either the carbohydrate-drink group or the placebo group. Which group do you think you were in?

    a. Carbohydrate-drink group

    b. Placebo group

    c. Don’t know

6. How was the drink taken?

    a. Large volume, less frequently throughout the RPM class (less than 3 sips)

    b. Moderate volume, moderately frequent throughout the RPM class (3 to 5 sips)

    c. Small volume, frequently throughout the RPM class (more than 5 sips)

    d. other (Please specify)

7. How did you feel about the drink?

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

24th February 2012

To the directors of All Season's Fitness Centre

My name is Vivian Lee and I am a Masters student at Massey University. I am currently looking to conduct a study that requires approximately 40 participants that attend the RPM classes that you provide. The study will be examining the effect of carbohydrate ingestion during exercise on health, fitness, quality of life and mood in recreational exercisers between the ages of 30 to 60. Carbohydrate is a well-known ergogenic aid and is also known to improve immune function, affect mood and perceived exertion. Studies on elite athletes examining the influence of carbohydrate ingestion during acute exercise (single sessions) are abundant however studies on recreational exercisers are lacking. Therefore, this study will be using male and female recreational exercisers between the ages of 30 to 60, who attend 2-3 RPM classes per week. The participants will have the opportunity to assess their fitness levels, and also experience air displacement plethysmography (commonly known as BodPod), state-of-the art equipment that measures body composition.

The study also looks to assess the effectiveness of regular attendance of RPM classes for 10 weeks. This may form positive publicity for the classes which your gym may benefit from. I would really like the opportunity to work with the members of your gym as I am also a member that enjoys your facilities.

Please do not hesitate to contact me if you have any queries regarding this study.

Yours faithfully,

Vivian Lee

dpwlek@hotmail.com

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