

EFFECTS OF EXERCISE MODALITY ON
METABOLIC RATE, BODY COMPOSITION, DIETARY INTAKE,
AND EATING BEHAVIOUR

by

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ABSTRACT

This study was designed to investigate the effects of exercise as a strategy for weight management in overweight women. Specifically, the effects of exercise modality on metabolic rate, body composition, dietary intake, and eating behaviour were examined. Participants included 41 overweight, sedentary females aged 25 to 49 years, who had a defined history of dieting. Experimental (n=26) and control (n=15) participants were recruited separately. Participants in the experimental group were randomly assigned to either an endurance- or a resistance-training exercise class. Exercise classes designed for a sedentary population were scheduled three times per week for a duration of three months. Pre- and post-intervention measures included resting energy expenditure (REE), anthropometry (height, weight, 8 skinfolds and 6 girth measurements), a three-day diet record, and the Three-Factor Eating Questionnaire. Results indicated that exercise modality had no effect on REE, dietary intake, or eating behaviour. Exercise, regardless of modality, had a significant effect on body composition ($p=0.0001$) as shown by a significant decrease in the sum of skinfolds for the two exercise groups relative to the control group ($p<0.0001$). No differences in fat-free mass were observed between groups. Regardless of modality, exercise also resulted in an increased estimated VO_2 max ($p=0.012$), based on a one-mile walking test. The pattern of weight change of the groups was different ($p=0.029$) over the three month

period. Whereas the exercise groups maintained their weight, the control group gained weight (approximately 2.5 kg). Thus, although exercise modality had no effect, the benefits of exercise per se, such as decreased body fat, increased fitness level, and weight maintenance, were observed in this population. Implications for future studies concerning exercise prescription, exercise adherence, and weight management include preferences for walking as a mode of exercise and the importance of incorporating factors such as group homogeneity, social networking, commitment to a goal, and a leader with a health-related background into an exercise program. Also, it was shown that exercise prevents seasonal weight gain that might otherwise occur in the absence of exercise.

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This thesis is dedicated to the 41 women who devoted the fall of 1992 to this study.

CHAPTER 1

INTRODUCTION

The purpose of the present thesis was to examine the effects of exercise as a strategy for weight management in overweight women. Although dieting or food restriction alone, or in combination with exercise, is also used for the purpose of weight control, this investigation focussed on exercise alone as an intervention. The reason for not including food restriction as part of the intervention is discussed in the next section.

This study took place in Vancouver, British Columbia during the fall of 1992. All preparations regarding recruitment of participants and the design of the exercise intervention were made during the preceding summer. The focus of the intervention was to compare two different exercise programs to a control group which received no exercise. Both exercise programs were designed at the University of British Columbia and the exercise classes were taught on campus by certified fitness instructors. The classes were scheduled three times per week for a duration of three months.

Specifically, the investigation assessed the effects of two types of exercise on four major dependent measures of importance to weight management: metabolic rate, body composition, dietary intake, and eating behaviour. The experimental design included pre-post measurements with participants reporting for pre-tests in July and August and then again for the post-tests in December after completion of the exercise program.

Aside from the potential health risks associated with excess body weight such as coronary heart disease, hypertension and stroke, diabetes, renal disease, gall bladder disease, pulmonary diseases, and certain types of cancer (McArdle, Katch, & Katch, 1991), overweight women were chosen specifically as the target population for a number of additional reasons. In general, overweight individuals are in need of an exercise program designed to encourage adherence and subsequent longterm weight control. The overweight woman is more likely to drop out of an exercise program for psychological reasons such as intimidation and self-consciousness than is a 'normal' weight woman (Gillett, 1988). Also, overweight women are less willing and able to participate in strenuous activities such as those experienced in commercial fitness programs. However, exercise adherence can occur in overweight women if the program is tailored to their concerns (Gillett, 1988). Designing such a program was a major undertaking of this study.

INTRODUCTION

In regards to weight loss behaviour, more overweight women (aged 20 to 64) than overweight men are trying to lose weight, yet significantly fewer of these women than men rate being active as one of the best two ways to lose weight (Health & Welfare Canada, 1993). In fact, more overweight women than men intend to lose weight by changing their eating habits rather than intending to become more active (Health & Welfare Canada, 1993). This implies that overweight women believe dieting to be a better, or easier, method of weight loss. It is suggested that dieting should not be encouraged for reasons discussed below and that exercise should be promoted as the 'healthy' alternative. Finally, few studies have examined the general effects of exercise in overweight women, possibly because of physiological and behavioural changes which occur with the menstrual cycle (Poehlman, 1989). For example, metabolic rate increases during the latter half, or follicular phase, of the menstrual cycle, as does dietary intake. Also, the scarcity of research on overweight women and exercise may be partly due to the fact that health risks associated with excess fat are not as high for overweight women as they are for overweight men. It has been shown that women can carry up to 60 lbs more fat than men without significantly increasing their cardiovascular risk, provided that they carry the excess fat primarily in the gluteal and femoral regions (Stanford & Shimer, 1990).

In addition to being female and overweight, it was required that the women in the study have a defined history of chronic dieting. It has been shown that women who diet repeatedly have a lowered muscle mass and metabolic rate relative to their body size, possibly resulting from the dieting (Steen, Oppliger, & Brownell, 1987), and/or a tendency to exercise less than lean women of the same age (Miller, Lindeman, Wallace, & Niederpruem, 1990). It was anticipated that exercise would reverse these effects.

1.1 STATEMENT OF THE PROBLEM

In North America, there is a high prevalence of overweight and obesity (Millar & Stephens, 1987). According to the 1990 Canada Health Promotion Survey (Health & Welfare Canada, 1993), 38% or six million Canadians over the age of 20 are "possibly overweight" or "overweight" as defined by a body mass index of 25-27, and greater than 27, respectively. Research shows that as little as 20% excess weight may increase medical risks and create the potential for psychological and social disabilities (National Institutes of Health, 1985).

According to the Canada Health Promotion Survey, those who are possibly overweight or overweight are the most likely to be trying to lose weight: 44% of those who are possibly overweight and 60% of those

who are overweight are trying to lose weight (Health & Welfare Canada, 1993). Differences between males and females are significant: 62% of females who are possibly overweight and 71% who are overweight versus 26% of males who are possibly overweight and 49% who are overweight report attempts to lose weight. Therefore, when comparing attempts to reduce excess weight, overweight women appear to be more concerned with their body size than overweight men.

Achieving weight loss is based on a fundamental concept of energy output versus energy input. Weight loss can be achieved by either 1) decreasing energy intake below daily energy requirements (dieting), 2) maintaining regular food intake and increasing energy expenditure through additional physical activity above daily requirements and/or increasing metabolic rate, or 3) combining both methods by decreasing daily food intake and increasing daily energy expenditure (McArdle, Katch, & Katch, 1991). For the majority of individuals, dieting has been the most popular method of weight loss (Broeder, Burrhus, Svanevik, & Wilmore, 1992b). In 1989, it was estimated that Americans spent approximately \$32 billion on diet related products and services and it is estimated that consumers will spend \$51 billion in 1995 (U.S. Weight Loss and Diet Control, 1989). Because 'normal' weight individuals, particularly women, utilize diet products and services, the percentage of these consumers who are actually overweight is unknown.

In general, dieting for weight loss purposes (regardless whether one is overweight or not) can result in negative behavioural, psychological, and physiological effects (Blackburn et al., 1989). This probably accounts for the high recidivism rates observed in dieters (Foreyt, 1987). Instead of choosing to eat 'healthier', individuals may resort to fasting, diet pills and supplements, liquid formula diets, or appetite suppressants. For some, failure to lose weight may be a result of skipping meals in favour of low nutrient, high fat snacks. Psychologically, dieting places individuals in a state of real or perceived deprivation which may lead to overeating (Kirkley, Burge, & Ammerman, 1988). Research also shows that repeat dieters, compared to non dieters, are characterized as having low self-esteem and an external locus of control (sense of having no personal control over one's life decisions) (Dykens & Gerrard, 1986). Dieting also predisposes women to a higher rate of depression than men due to a high failure to achieve and maintain weight loss by dieting (McCarthy, 1989).

Physiologically, the effects of dieting may include impaired nutritional status due to poor nutrition habits, increased metabolic efficiency, and decreased percent lean body mass (LBM) (Kirkley & Burge, 1989). For example, it has been found that severe energy restriction depresses metabolic rate by as much as 45% (Stordy, Marks, Path, Kalucy, & Crisp, 1977). Research also shows that as little as 14 days of a very-low-calorie-diet can result in a significant loss of LBM

equivalent to about 3 kg (Van Gaal, Vansant, & Leeuw, 1992). The loss of LBM may be particularly important because this may have subsequent effects on metabolic rate. Metabolic rate is partly determined by LBM therefore, a loss of LBM may result in a decreased metabolism.

Chronic dieting may also lead to the phenomenon of weight cycling (also referred to as 'yo yo dieting') where weight is repeatedly lost and gained. This phenomenon is frequently encountered by both professionals and clients of weight loss programs (Pasulka, 1987). Although it has been reported that health risks increase as the number of diet cycles increase (Brownell, Steen, & Wilmore, 1987), relatively little is known about the specific health implications of weight cycling (Lissner, Steen, & Brownell, 1992). It is known that with dieting alone, the body may become effective at adapting to a low energy intake, and experience a decrease in metabolic rate. The decrease in metabolic rate may also be associated with the loss of LBM which results from dieting. Research also shows that when obese people lose weight, the level of lipoprotein lipase increases in adipose cells (Kern et al., 1990). This enzyme facilitates fat synthesis and storage. High enzyme levels make it easier for formerly obese individuals to regain fat mass when they regain weight. Thus, the loss of LBM combined with a higher tendency to regain fat mass may cause changes in body composition. As a result of all of these factors, chronic dieting may lead to permanent

metabolic and physiological alterations which promote weight gain and make subsequent loss of weight more difficult (Blackburn et al., 1989).

Exercise is also used as a strategy to achieve weight loss.

Unlike dieting, however, exercise remains one of the best predictors of long-term weight control (Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Kayman, Bruvold, & Stern, 1990). It has been found that few obese women who regain weight after successful weight reduction have exercised regularly (Kayman et al., 1990). Still, it is not uncommon for women to take up vigorous exercise programs with the sole intention of losing weight (Davis, 1990). Those who begin such exercise programs, however, often do not exercise long enough to attain their goal weight or they stop exercising due to factors such as lack of time, lack of willpower, lack of finances, lack of facilities, and lack of an exercise partner (Johnson, Corrigan, Dubbert, & Gramling, 1990). It may be that the initial intensity of these vigorous exercise programs is too demanding to encourage exercise adherence.

Exercise may be important in breaking the pattern of cyclic weight loss and regain and in reducing the high prevalence of dieting. It has been shown that exercise can prevent the decrease in metabolic rate often associated with dieting (Mole, Stern, Schultz, Bernauer, & Holcomb, 1989) and may even increase metabolic rate during non-active times (Poehlman, Melby, Bradylak, & Calles, 1989). Certain types of

exercise may also be important in indirectly increasing metabolic rate during non-active times. Exercise with a resistance- or weight-training component is more effective at increasing muscle mass than endurance exercise. Muscle mass is an important predictor of metabolic rate. As evidence, it has been shown that muscle mass is highly correlated with metabolic rate during non-active times (Ravussin & Borgardus, 1989). Exercise in general has also been shown to result in some regulation of appetite (Hawks, 1989). It appears that overweight individuals do not eat more to compensate for the energy expired during exercise (Titchenal, 1988). These individuals either maintain or decrease energy intake in response to exercise.

Because of the physiological benefits of exercise compared to dieting, and because exercise is associated with long-term weight maintenance and weight loss, regular exercise should be encouraged for overweight and obese individuals. Because high dropout rates are often associated with exercise programs, it is important that programs be designed to influence exercise adherence, so that goal weight can be achieved and maintained in overweight women.

This investigation is based on the premise that chronic dieting results in a depressed metabolic rate and a loss of muscle mass and that exercise may reverse this effect and promote long-term weight control.

It is thought that the type of exercise may be important in achieving this end.

1.2 DEFINITION OF TERMS

Resting energy expenditure (REE)

Resting energy expenditure is the technical term used in reference to metabolic rate. Resting energy expenditure constitutes 60 to 75% of daily energy expenditure and is the energy associated with the maintenance of major body functions such as respiration and circulation (Wardlaw & Insel, 1990). It does not include energy needs for activity or digestion and absorption of food. While at rest, about 40% of this energy is used by the brain and liver together, about 20% by muscle, and about 2-5% by adipose tissue (Wardlaw & Insel, 1990).

Resting energy expenditure is essentially the same as basal energy expenditure (BEE) except that subjects do not need to meet the strict conditions used for a BEE determination. The strict criteria for BEE include being fasted for the previous 12 hours and being in a warm, quiet environment during the measurements. The best time of day to determine BEE is just after waking from a night's sleep. If a person is at rest but cannot meet the above conditions for BEE, for example, they have to be transported to the testing site, then the test actually

yields REE values. Often, BEE and REE are used interchangeably. The difference between the two measurements is about 3%, BEE being slightly lower than REE (Wardlaw & Insel, 1990).

Lean body mass (LBM)

Lean body mass refers to the muscle component of the body. This mass contains a small percentage of essential fat stores (perhaps as much as 3%), primarily within the central nervous system, bone marrow, and internal organs (McArdle et al., 1991). As mentioned above, muscle mass uses about 20% of the body's REE while at rest. LBM is therefore a major predictor of REE.

Fat-free mass (FFM)

Like lean body mass, fat-free mass also refers to the muscle component of the body. However, fat-free mass (FFM) refers to the body mass devoid of all extractable fat (McArdle et al., 1991). The only difference between the fat-free mass and lean body mass is the essential lipid stores in brain, internal organs, bone marrow, and spinal cord (McArdle et al., 1991). FFM also contains a small percentage of essential lipids when fat is extracted by the usual chemical methods (McArdle et al., 1991). There is a conceptual difference between FFM and LBM but it is difficult to distinguish technically between them as the estimated difference is as little as 2% lipid (Sheng & Huggins, 1979). Because the difference between the two terms is minimal, FFM and

LBM are often used interchangeably. For the purpose of this study, FFM will be used to refer to muscle mass.

1.3 RATIONALE OF EXERCISE INTERVENTION

An exercise intervention may be important in breaking the pattern of cyclic weight loss and regain and in reducing the high prevalence of dieting. If poor weight maintenance is due to high dietary intake, low physical activity, and/or a lowered metabolism, then attempts must be made to achieve energy balance and to increase metabolic rate.

The *type* of exercise may be critical. Resistance exercise which includes a weight training component is known to cause changes in body composition, particularly increases in muscle mass or fat-free mass (FFM). Fat-free mass is considered to be a good predictor of REE. It is expected that resistance exercise that results in increases in FFM will subsequently increase REE in individuals undergoing this type of exercise. Over the long-term, an increase in REE could add to, or possibly outweigh, the effects of endurance exercise which may only increase energy expenditure during the exercise period itself.

Endurance-training exercise and resistance-training exercise were the two modes of activity chosen for this study. The endurance training

was delivered in the form of a walking program whereas the resistance-training exercise program incorporated the use of hand-weights and was comprised of toning exercises which involved major muscle groups. In addition to the above rationale concerning these two types of exercise and REE, other physiological benefits of both modes of exercise have been documented.

It has been shown that the effects of walking include weight loss (Porcari, Ebbeling, Ward, Freedson, & Rippe, 1989), a decrease in fat mass (Bergman & Boyungs, 1991; Pollock, Dimmick, Miller, Kendrick, & Linnerud, 1975; Porcari et al., 1989), a maintained or increased FFM (Porcari et al., 1989), and an increased maximum oxygen uptake ($\text{VO}_2 \text{ max}$) (Jette, Sidney, & Campbell, 1988). It has been shown that the effects of resistance-training exercise, or exercise with a weight-training component, include weight maintenance, a decrease in body fat mass, an increase in FFM (Broeder et al., 1992b), and possible increases in $\text{VO}_2 \text{ max}$ (Broeder et al., 1992b; Stone, Fleck, Triplett, & Kraemer, 1991). The effect that resistance training has on aerobic and cardiorespiratory fitness may be in part due to shifts in the lactate threshold (Stone et al., 1991). Very few studies have examined the effects of resistance training in overweight women, or women in general.

1.4 PURPOSE OF STUDY

This study was designed to investigate the effects of exercise as a means of weight management. More specifically, the purpose was to assess the effects of two exercise modalities on REE, body composition, dietary intake, and eating behaviour in overweight women, and to consider implications for future study concerning exercise prescription, exercise adherence, and effective weight management. Overweight women with a defined history of dieting behaviour were chosen because such individuals have been shown to have a lowered fat-free mass (FFM) and metabolic rate relative to their body size (Schlundt et al., 1991) possibly as a result of chronic dieting (Garrow, Durrant, Man, Stalley, & Warwick, 1978; Ravussin, Burnand, Schutz, & Jequier, 1985; Steen et al., 1987) and/or a tendency to exercise less than their lean peers (Miller et al., 1990). Also, unlike 'normal'-weight women, overweight women have been shown to consume energy intakes determined by factors other than exercise such as variety, palatability, and availability of food and other sensory and psychological factors (Pi-Sunyer & Woo, 1985). Therefore, for overweight women, food-related cues seem more important than exercise-generated signals. Although there is little in the literature relating exercise to specific aspects of eating behaviour, it was thought that response to these factors may change with an exercise intervention. Once individuals are aware of the energy used during exercise and the possible effects on metabolic rate, it may

relieve the anxiety associated with 'counting calories' and result in different energy consumption patterns. Because of the psychological, social, and potential health risks associated with as little as 20% excess body weight (National Institutes of Health, 1985) and repeated weight gains and losses, it was anticipated that overweight women would benefit greatly from participation in this study.

1.5 NULL HYPOTHESES TESTED

- 1) There will be no changes in metabolic rate over time as a result of exercise modality.
- 2) There will be no changes in body composition over time as a result of exercise modality.
- 3) There will be no changes in dietary intake over time as a result of exercise modality.
- 4) There will be no changes in eating behaviour over time as a result of exercise modality.

1.6 LIMITATIONS WITH RESPECT TO GENERALIZABILITY

Results from the study are only representative of the population of women who were involved, due to the nature of the recruitment

methods. The sample of women was a self-selected sample. Participants volunteered for the study - they were not randomly drawn from a population of overweight women who met the specific criteria. Also, participants volunteered for the exercise intervention and the control group under different circumstances. For those interested in the exercise intervention, the study was advertised as an "Exercise and Weight Management Study". For practical and ethical reasons, it was not appropriate to randomly assign subjects who responded to this advertisement to a control group. Participants assigned to a control group who were interested in an exercise program would probably drop out of the study. Further, it would have been unfair to offer weight management as an incentive to individuals who would be assigned to a control group, a group which would unlikely achieve this end. Similarly, chances were that those assigned to an exercise program who were not interested in exercise would also drop out. It is unclear what, if any, differences existed between the control and experimental groups apart from motivation to exercise and lose weight. However, it was suspected that motivational factors alone would have no differential effect on the dependent variables over time. Once the desired number for the experimental group had been exceeded, additional volunteers for this group were given the option of being in the control group while on a waiting list for the experimental group. No volunteer interested in the exercise intervention was interested in being 'wait-listed' as a control.

The study took place on the West Coast of Canada in British Columbia where attitudes to exercise are more favourable than those in the central and eastern part of the country (Stephens, Jacobs, & White, 1985). Information about socio-economic status was not collected as it was thought that it would be too intrusive and that this information would not influence the results over time. However, most of the women appeared to be from a middle-class background, living in the West Side of Vancouver, and all owned, or had access, to a vehicle. With the exception of one woman, all had some affiliation with the university either through work or as students. Thirty-nine of the 41 women were Caucasian.

1.7 SIGNIFICANCE OF THE STUDY

Knowledge gained from this study will be applicable for planning exercise prescription and public health education for overweight women. The study will add new information to previous results concerning the benefits of exercise over dieting by providing insight into the *type* of exercise that should be prescribed. This research will provide overweight women with a positive alternative to dieting.

To date, only one study has compared the effects of resistance training to endurance training on REE and body composition (Broeder et al., 1992b). Broeder et al (1992b) investigated the effects of either 12 weeks of high-intensity endurance exercise or heavy resistance training on metabolic rate in nondieting, previously active males aged 18-35. Their results suggested that both endurance and resistance training may help to prevent an attenuation in REE, normally observed during extended periods of negative energy balance, by either preserving (endurance training) or increasing (resistance training) a person's FFM. Their results also showed no significant differences in energy intake between the control and two experimental groups. The present study served to extend this research to include sedentary, overweight women, dietary intake and selection, and eating behaviour.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This investigation encompasses the areas of nutrition, exercise, health education, and sports medicine. It is often the case that these domains address the issue of weight management and weight control quite independently of each other. This investigation will attempt to integrate the research from these areas and provide more coherent and effective strategies to cope with the complex area of diet, exercise, and weight management.

As discussed, there are many negative consequences associated with dieting for weight loss. Dieters may resort to extreme measures such as diet pills and supplements, starvation, and appetite suppressants or else they may skip meals in favour of low nutrient, high fat snacks. Dieting places individuals in a state of real or perceived deprivation which may lead to overeating. Dieting also may result in a low self-esteem, an external locus of control, and depression possibly due to a high failure to achieve and maintain weight loss using this method. Finally, chronic dieting may lead to metabolic and physiological alterations which promote weight gain and make subsequent loss of weight

more difficult. The body may adapt to the lowered energy intake and respond by decreasing metabolic rate as well as experience a loss of FFM which may further depress metabolic rate. Chronic dieting resulting in weight cycling (repeated weight loss and regain) may also lead to changes in body composition due to losses of FFM when weight is lost and the tendency to regain fat mass when weight is regained.

Exercise has been said to be one of the few consistent predictors of long term weight control (Brownell et al., 1986; Kayman et al., 1990). As evidence, it has been found that few obese women who regain weight after successful weight reduction have used exercise to help lose weight (Kayman et al., 1990). There are a number of reasons why exercise may be preferential to dieting. While dieting may cause a lowered metabolism, a loss of FFM, erratic eating behaviour as well as have a negative psychological impact, exercise may have positive influences on all of these factors. However, the theories supporting the relationship between exercise and weight management are somewhat controversial.

2.2 THEORIES OF EXERCISE FOR WEIGHT MANAGEMENT

This section will examine some of the theories supporting the relationship between exercise and weight management. These include the

direct effects of exercise on metabolic rate, the effects of exercise on metabolic mass or fat-free mass, and the effects of exercise on dietary intake and eating behaviour. Although the psychological effects of exercise are well documented (Chaouloff, 1989; Raglin, 1990; Taylor, Sallis, & Needle, 1985; Thoren, Floras, Hoffmann, & Seals, 1990) these will not be discussed as they were not examined in this study.

2.2.1 Direct Effect of Exercise on Metabolic Rate

Exercise appears to influence resting energy expenditure (REE) directly (Poehlman, 1989). It is possible that the energy cost associated with exercise increases the rate of protein synthesis which may cause an increase in REE (Poehlman, 1989). It may be that changes in REE in response to endurance training are accounted for by increases in the rate of norepinephrine appearance in circulation (Poehlman & Danforth, 1991; Poehlman et al., 1992). It has been shown that norepinephrine levels are increased two to sixfold by light to moderate exercise (McArdle et al., 1991). One of the functions of norepinephrine is to increase glycogen catabolism and fatty acid release. Hypersecretion of this hormone/neurotransmitter can result in an increased metabolism (McArdle et al., 1991).

The theory concerning the direct effect of exercise on metabolic rate is somewhat controversial. Consistent long-lasting effects of

exercise on REE have not been reported. Some investigations have shown an increase in energy expenditure during non-active times (Bielinski, Schutz, & Jequier, 1985; Lennon, Nagel, Stratman, Shrago, & Dennis, 1985; Mole et al., 1989; Poehlman, Melby, & Bradylak, 1988; Poehlman, Melby, Bradylak, & Calles, 1989; Tremblay et al., 1986), while others have found no appreciable energy expenditure beyond that generated by the exercise period itself (Bingham, Goldberg, Coward, Prentice, & Cummings, 1989; Broeder, Burrhus, Svanevik, & Wilmore, 1992a; Davis, 1983; Elliot, Goldberg, & Kuehl, 1988; Freedman-Akabas, Colt, Kissileff, & Pi-Sunyer, 1985; Goldberg, Prentice, Davies, & Murgatroyd, 1990; Hill, Heymsfield, Mcmannus, & DiGirolamo, 1984; LeBlanc, Diamond, Cote, & Labrie, 1984; Staten, 1991; Tagliaferro, Kertzer, Davis, Janson, & Tse, 1986; Tremblay et al., 1990; Warwick & Garrow, 1981; Weststrate, Weys, Poortvliet, Deurenberg, & Hautvast, 1990; Woo, Garrow, & Pi-Sunyer, 1982).

The protocols of the studies both supporting and refuting the claim that exercise and exercise training have direct effects on REE are quite variable. They range from cross-sectional to intervention studies looking at fit versus unfit individuals, obese versus lean individuals, and males versus females. These studies differ in the type of exercise employed and whether exercise alone is the intervention or whether it is used in conjunction with a diet component. Aside from the differences in FFM associated with different exercises, the type of exercise is also

important in terms of energy expenditure. The immediate energy cost of a typical resistance training workout may be substantially lower than that of aerobic activity (McArdle et al., 1991). The sample sizes are also not consistent. These studies also differ in the timing of the REE tests, for example, Elliot (1988) tested REE 1.5 hours after a cycling bout whereas Staten (1991) tested individuals in the morning 12-15 hours after exercise.

In addition to variable protocols of such studies, it is possible that a threshold of exercise intensity needed to increase REE (Lennon et al., 1985) accounts for the discrepant results. Bahr, Inges, Vaage, Sejersted, and Newsholme (1987) suggest that an exercise intensity of greater than 50% $\dot{V}O_2$ max may be required to produce significant increases in REE during non-active times. It is difficult to draw this conclusion from the studies mentioned, however, because the majority of them have not defined exercise intensity.

2.2.2 Effects of Exercise on Metabolic Mass

Less controversial is the indirect effect of exercise on REE due to its effect on body composition. It has been shown that many athletes of both genders have a larger fat-free mass (FFM) and a smaller fat mass relative to their body size than their sedentary peers (Forbes, 1987). Generally, both endurance training and resistance training decrease

relative body fat but the effect on FFM may depend on the type of exercise. Endurance training results in the loss of body fat while maintaining, or slightly increasing FFM (Andersson et al., 1991; Bergman & Boyungs, 1991; Broeder et al., 1992b; Hill, Sparling, Shields, & Heller, 1987; Keim et al., 1990; Pollock & Wilmore, 1990; Wilmore, 1983); resistance training results in a decrease of total fat while significantly increasing FFM (Ballor, Katch, Becque, & Marks, 1988; Broeder et al., 1992b). Preservation of FFM is critical during weight loss. An increase in the proportion of FFM to total body weight may subsequently increase REE. Research shows that FFM is an important predictor of REE (Ravussin & Borgardus, 1989; Ravussin, Burnand, Schutz, & Jequier, 1988; Segal, Lacayanga, Dunaif, Gutin, & Pi-Sunyer, 1989; Webb, 1981; Weinsier, Schutz, & Bracco, 1992). Resistance training, especially, may increase REE because it promotes significant skeletal muscle development thereby increasing the total amount of metabolically active tissue (Broeder et al., 1992a). Therefore, although the immediate energy cost of a typical resistance training workout may be substantially lower than that of aerobic activity, this type of exercise may increase lean tissue which may subsequently increase REE. Thus, resistance exercise may indirectly aid long-term weight maintenance/weight reduction (Walberg, 1989).

2.2.3 Effects of Exercise on Dietary Intake and Eating Behaviour

It has been postulated that exercise curbs 'appetite'. However, this theory has not been consistently documented. While some research demonstrates the inhibitory effect of exercise on food intake in humans (Boileau, Buskirk, Horstman, Mendez, & Nicholas, 1971; Oscai & Williams, 1968), the majority of recent research refutes this claim (Andersson, Rebuffe-Scrive, Terning, Krotkiewski, & Bjorntorp, 1991; Ballor, McCarthy, & Wilterdink, 1990; Bergman & Boyungs, 1991; Broeder, Burrhus, Svanevik, & Wilmore, 1992b; Keim, Barbieri, & Belko, 1990; Pi-Sunyer & Woo, 1985; Staten, 1991; Thompson, Wolfe, & Eikelboom, 1988). It appears that while exercise may not actually act as an appetite suppressant, at least it does not seem to increase appetite to a degree which exceeds the energy output created by the exercise (Hawks, 1989).

The situation varies slightly between obese and lean individuals. While lean individuals have been found to increase voluntary energy intake in response to moderate exercise in order to maintain energy balance (Durrant, Royston, & Wloch, 1982; Poehlman, Gardner, & Goran, 1992; Titchenal, 1988; Woo & Pi-Sunyer, 1985), obese individuals do not increase energy intake when exposed to exercise training (Durrant et al., 1982; Titchenal, 1988; Woo et al., 1982). In other words, energy output resulting from exercise does not regulate energy intake closely

in the obese. Consequently, although exercise may neither enhance nor inhibit appetite in obese individuals, energy intake remains fixed resulting in a negative energy balance (Pi-Sunyer & Woo, 1985). Therefore, the beneficial effect of exercise on body weight in obese individuals is limited to the extra energy expended during exercise itself (assuming that changes in FFM are not occurring) and not to changes in dietary intake.

Another route by which exercise may lead to better regulation of food intake is the observed change to a higher carbohydrate (CHO) intake, sometimes at the expense of fat (Ballor & Poehlman, 1992; Kohrt, Obert, & Holloszy, 1992; Poehlman et al., 1992; Saris, 1989). Exercise-induced depletion of muscle and liver glycogen could be a factor influencing the consumption of dietary CHO (Titchenal, 1988). It has been shown that muscle glycogen stores can be significantly lowered within one hour of moderate intensity exercise (Astrand & Rodahl, 1977). An increased CHO-fat intake ratio is not as energy efficient as an increased fat-CHO intake ratio. The conversion of dietary CHO to fat utilizes 23% of the original energy from CHO, whereas for dietary fatty acids, the cost of conversion to fat is only 3% (Saris, 1989). Thus, more energy is required to convert dietary CHO to fat stores than to convert dietary fat to fat stores.

In addition to the amount and type of food eaten in response to exercise, there are other aspects of eating behaviour such as the frequency, size, and timing of meals which may also influence energy balance. Three aspects of eating behaviour were investigated: restrained eating, disinhibited eating, and hunger. Restrained eating refers to the conscious tendency to control eating behaviour. Disinhibited eating refers to the tendency to lose control of eating behaviour, and hunger refers to the subjective sensation of hunger (Weissenburger, Rush, Giles, & Stunkard, 1986). Few studies have examined the effects of exercise on these three factors.

2.3 METHODOLOGICAL PROBLEMS OF PREVIOUS STUDIES

Results of exercise studies in the area of weight management have been inconsistent. Interpretation and comparison of results depends on initial level of fitness and specificity of testing and training (Broeder et al., 1992b, Schlundt et al., 1991). Often, experimental protocols are not long enough to see the desired effects (Pi-Sunyer & Woo, 1985). For example, middle-aged sedentary and older individuals may take several weeks to adapt to the initial rigors of training and thus may need a longer adaptation period to get the full benefits from an exercise program (Broeder et al., 1992b). Many studies lack control groups or fail to look at the effects of exercise in isolation of food

restriction. As mentioned, exercise intensities are highly variable and are not always defined. It is also possible that only those committed to weight loss volunteer for studies and that only those who see success complete the entire study (Pi-Sunyer & Woo, 1985). In summary, there is a need to standardize the procedures of these studies with regards to participants' fitness and motivational levels, the length, specificity, and intensity of training programs, and inclusion of control groups.

Metabolic studies are often inconsistent in the timing of indirect calorimetry measurements. Previous exercise or the last meal eaten may interfere with the measurements. REE measurements need to be controlled for these factors as well as for situational influences such as transport to the testing site and the specific testing conditions. It has been shown that those participants who are transported to the testing site in the morning as opposed to those who are treated as inpatients have significantly higher REE values (Berke, Gardner, Goran, & Poehlman, 1992).

Other factors such as gender differences must also be taken into account with studies examining the effects of exercise. The majority of exercise training and REE studies are done on male subjects, perhaps to avoid REE and dietary changes which occur with the menstrual cycle (Poehlman, 1989). Research shows that 24-hour energy expenditure may increase by 9% in the post-ovulation or luteal phase of the menstrual

cycle (Webb, 1986). It is thought that this increase is due to increased concentrations of progesterone during this phase (Meijer, Westerterp, Saris, & ten Hoor, 1992). It has also been shown that dietary intake increases during this time possibly to compensate for the increased energy expenditure (Tarasuk & Beaton, 1991). Controlling for REE and dietary changes which coincide with different phases of the menstrual cycle requires careful scheduling, especially when over 40 women are involved.

There are also problems associated with exercise and food intake studies. One problem is reliance on subjects' self reports regarding diet records. Subjects may fail to record meals, omit foods, and misrecord portion sizes and preparation techniques (Ravussin et al., 1985). Failure to record meals and omission of foods may particularly be a problem in overweight women. It has been shown that overweight women consistently under report dietary intakes (Black et al., 1993). However, because this is a consistent behaviour, it was not expected that the tendency to under report would change between the pre and post tests. Finally, diet studies may require careful weighing of food in cases where weights are not given. Such monitoring of food intake itself may intrude upon daily life (Pi-Sunyer & Woo, 1985).

2.4 SUMMARY OF LITERATURE REVIEW

It appears that several reasons account for exercise as one of the few consistent predictors of long-term weight control. Exercise may directly influence metabolic rate through increasing the rate of protein synthesis or norepinephrine appearance in circulation. This effect results in a higher metabolic rate during non-active times and therefore an increased total energy expenditure.

Exercise may indirectly influence metabolic rate due to its effects on body composition, particularly FFM. Preserving or increasing FFM is critical for long-term weight management or weight loss to occur because FFM is an important predictor of metabolic rate. Preserving or increasing FFM subsequently maintains or increases REE. The type of exercise may be important for increasing FFM. Research shows that resistance-training exercise is more effective at increasing FFM than is endurance-training exercise. Therefore, resistance-training exercise which results in a significant increase in FFM may subsequently increase metabolic rate and thus aid in weight management and/or weight reduction.

Exercise may also have regulatory effects on food intake. The effect of exercise on dietary intake may differ between overweight and lean individuals. While lean individuals tend to increase their dietary

intake in order to compensate for the negative energy balance caused by exercise, it has been shown that overweight individuals do not change dietary intake in response to exercise. An exercise intervention in this population, therefore, may result in a negative energy balance. For reasons relating to exercise-induced depletion of muscle and liver glycogen, exercise may also lead to a higher CHO:fat intake ratio which may have beneficial effects on weight maintenance. The conversion of dietary CHO to stored fat in the body requires more energy than does the conversion of dietary fat to stored fat. The effects of exercise on specific aspects of eating factors such as restrained eating, disinhibited eating, and hunger are unknown.

Methodological problems of previous studies in the area of exercise and weight management include lack of standardization regarding participants' fitness and motivational levels, duration, specificity, and intensity of training programs, lack of control groups, timing of REE measurements, gender differences, and reliance on self report for dietary intake. The present study sought to overcome some of these methodological problems by looking only at women and by standardizing participants' fitness levels (all participants had to be previously sedentary). Attempts were made to 'equate' the two exercise programs in terms of time and frequency. A control group was also included in the study. REE measurements were scheduled in the mornings and all participants were instructed to not eat and not exercise during the 12

LITERATURE REVIEW

hours preceding the tests. They were encouraged to get a ride to the lab so as not to cause an elevation in their REE values. Finally, the women came in for their REE tests during the follicular phase of their menstrual cycle to avoid increased values that occur in the luteal phase. Similarly, all diet records were filled out during the follicular phase of the menstrual cycle. Although there is a problem with relying on self report diet records, especially in overweight women, extensive instruction and encouragement was given to promote accurate recording of dietary intakes.

CHAPTER 3**METHODS****3.1 STUDY DESIGN**

The experimental design was a 3 (Group) by 2 (Time) factorial design with repeated measures on the time factor. It was a pre-post design involving an endurance-training group, a resistance-training group, and a control group. Participants came to the testing centre during June, July, and August for the pre tests and then again during December for the post tests. Figure 1 is a depiction of the experimental design. The exercise intervention occurred during September, October, and November. One exercise group received an endurance-training program which was primarily a walking program. The other exercise group received a resistance-training program which incorporated light hand weights for the purpose of increasing muscle mass. The exercise intervention is discussed in more detail later in this chapter.

Group	Pre	Post
Endurance (n=11)		
Resistance (n=15)		
Control (n=15)		

Figure 1. Experimental Design: 3 (Group) by 2 (Time) Factorial Design with Repeated Measures on Time

Four major variables related to weight management were to be measured pre and post: metabolic rate (REE), body composition, dietary intake, and eating behaviour. The metabolic tests were done in the early morning using a metabolic cart at the Allan McGavin Sports Medicine Centre, University of British Columbia. Body composition was analyzed as two sub-variables: the sum of skinfolds and fat-free mass. Values for both of these variables were determined by anthropometric measurements. Dietary intake was analyzed as three sub-variables: total energy ingested, percent energy from fat, and percent energy from carbohydrate. This information was obtained from 3-day diet records that subjects completed at home. Eating behaviour was analyzed as three specific factors determined by the Three-Factor Eating Questionnaire (Stunkard & Messick, 1985). These factors were: restrained eating, disinhibited eating, and hunger.

3.2 PARTICIPANTS

The intention was to have at least 20 participants per group. For various reasons this goal was not achieved (see Attrition). At the beginning of the exercise program, there were 53 participants who had met the criteria and had undergone all initial testing. By the end of the program, the total sample size was 41.

Participants had to meet certain criteria with respect to gender, age, degree of overweight, fitness level, and history of dieting as outlined in the advertisements used to recruit them. As mentioned previously, overweight women were investigated for various reasons, one being that these women generally do not utilize exercise as a means of weight control/weight loss. Specifically, a range of 20 to 50 lbs overweight was chosen as the criterion for overweight. Twenty to 50 lbs overweight corresponds to a body mass index (BMI) of 26-33. This specific weight criterion was chosen because the majority of women in North America over the age of 20 who are overweight, are in this weight category (Najjar & Rowland, 1987; National Center for Health Statistics, 1981). Roughly 78% of overweight women in the United States fit into this weight category.

Participants between the ages of 25 and 49 were recruited. This age group was chosen for three reasons. Firstly, this age group has been identified as homogeneous in regards to Recommended Nutrient Intakes (Health & Welfare Canada, 1990b). Women in this age category all have similar basic nutrient requirements. Secondly, in Canada, the highest number of overweight women as defined by BMI's greater than 27 are found in this age category (approximately 702,160 women) compared to all other age categories combined (Health & Welfare Canada, 1993). Thirdly, within this age group, females who are overweight appear to have the greatest propensity to become considerably heavier in a

subsequent 10-year period (Williamson, Kahn, & Remington, 1990). This may be a critical time in their lives to intervene with an exercise program.

Participants were classified as weight cyclers as determined by a dieting history questionnaire and personal interviews (they had tried 3 or more times to lose weight in the last year; and they had lost and regained 10 pounds, 3 or more times in the last 5 years). Having a history of dieting and weight cycling, it was assumed that these women would be interested in trying an exercise program instead of another diet program. Participants also had to be sedentary, meaning that they exercised less than once per week, as classified by the Canada Health Promotion Survey (Rootman, 1988). Exercise has been shown to reverse the metabolic effects of dieting, thus previous activity would interfere with the expected changes which could be attributed to the exercise intervention. Also, because the intention was to introduce exercise to a dieting population with very little experience with exercise, it was important that all participants were at the same baseline fitness level.

Finally, participants had to be non-smokers (nicotine increases metabolic rate), and free from any acute or chronic illness (such as thyroid disease) that might affect metabolism and/or the ability to exercise.

3.2.1 Recruitment

Volunteers for the study were recruited through an advertisement in a University of British Columbia monthly newspaper, and by flyers posted in buildings around the campus (see Figure 2). Subjects in the treatment groups were offered free exercise classes, possible long-term weight maintenance, free metabolic testing, and a free nutritional analysis in exchange for participation in the exercise intervention.

**EXERCISE AND WEIGHT MANAGEMENT
STUDY**

ARE YOU SICK OF DIETING?

Female volunteers needed to participate
in a 3-month exercise program where the
effects of exercise on metabolic rate will
be tested.

You get

- FREE EXERCISE CLASSES
- FREE NUTRITIONAL ANALYSIS
- FREE METABOLIC TESTING
- POSSIBLE LONG-TERM WEIGHT MAINTENANCE

Volunteers must be:

- approx 20-50 lbs overweight
- non smokers
- sedentary (exercise less than 1x/week)
- people with a history of dieting (have tried 3 or more times to lose weight in last year and have lost and regained 10 lbs 3 or more times in last 5 years)
- between 25 and 49 years old
- available mid-June to mid-Dec
- free from acute and/or chronic diseases

Figure 2. Advertisement for the Experimental Group

The control group was recruited separately. Those interested in the exercise intervention responded to the advertisement "Exercise and Weight Management Study". For practical and ethical reasons, it was not appropriate to assign individuals interested in the exercise program to a control group. As mentioned, those assigned to a control group who were interested in an exercise program would probably drop out. In addition, it would have been unfair to advertise the study as "Exercise and Weight Management Study" to individuals who would end up in a control group which would do nothing to achieve this end. Similarly, those assigned to an exercise program who were not interested in exercise would also probably drop out. Once the desired number for the experimental group had been exceeded, additional volunteers interested in the exercise intervention were given the option of being controls on a waiting list for the intervention. No volunteer interested in the exercise intervention was willing to 'wait-list' as a control.

Subjects in the control group were recruited through a similar advertisement with the exception of being offered the exercise intervention and possible weight maintenance. Criteria pertaining to age, sex, weight, and dieting history was the same as it was for the treatment groups. Subjects in the control group were offered free metabolic testing and a free nutritional analysis in exchange for participation in the study (see Figure 3).

STUDY
DO YOU WANT TO KNOW YOUR
METABOLIC RATE?

Female volunteers needed to participate in nutritional study.

You get **FREE NUTRITIONAL ANALYSIS**
 FREE METABOLIC TESTING

Volunteers must be:

- approx 20-50 lbs overweight
- non smokers
- sedentary (exercise less than 1x/week)
- people with a history of dieting (have tried 3 or more times to lose weight in last year and have lost and regained 10 lbs 3 or more times in last 5 years)
- between 25 and 49 years old
- available mid June
- free from acute and/or chronic diseases

Figure 3. Advertisement for the Control Group

Those interested in the experimental group but unable to make the time commitment for various reasons such as work schedule, lack of babysitting services, and distance from campus were given the option of

being in the control group. They were told that if they became part of the control group, any intentions to exercise would have to be postponed until completion of the study. Through telephone contact and personal interviews at the time of the post tests, it was confirmed verbally that control participants did refrain from exercise during the three month intervention period.

3.3 PROCEDURES

Participants expressed their interest in the study during June, July, and August through telephone contact, at which time the inclusion criteria was confirmed. Participants who were 'not heavy enough' or 'too heavy' were assured that it was because the subject criteria had been set beforehand for the various reasons discussed previously.

Participants reported to the study centre on two separate occasions for the initial testing. During the first visit, anthropometric measurements were taken and questionnaires including the consent form (see Appendices A and B), a subject information sheet (see Appendix C), the Weight Cycling Questionnaire (see Appendix D), and the Three-Factor Eating Questionnaire (see Appendix E) were administered. The Weight Cycling Questionnaire was used to determine the number of times subjects had dieted in the past five years and the amount of

weight lost and regained in that time. This questionnaire is based on questions used in other studies on weight cycling (Steen, Oppliger, & Brownell, 1988) which focus on frequency of dieting, the amount of weight lost and regained after each diet, and trends or patterns in weight fluctuation. It has been shown that women are able to report with satisfactory reliability the number of diets in which they have engaged, as well as the total weight loss resulting from these diets (Wadden et al., 1992).

During the first visit, instructions were also given on how and at what phase of the menstrual cycle to fill out the diet record (see Appendix F). Participants were then scheduled to return for an early morning metabolic test during the follicular phase of their menstrual cycles.

During the second visit, in addition to having their metabolic rates tested, those interested in the exercise intervention were administered a Physical Activity Readiness Questionnaire (see Appendix G). This brief questionnaire identifies those for whom physical activity may be inappropriate or those who should have medical advice concerning the type of activity most suitable for them. At this time, participants interested in the exercise intervention were also given a Physician's Signature Form that explained the nature of the two exercise

programs and that required their physician's signature to approve of their participation in the study (see Appendix H).

Of 83 women interested in the study, 72 participants underwent initial testing. Of these, 12 were ineligible for reasons discussed later and 7 withdrew from the study. Fifty-three participants returned for the second set of tests. Of the 53, 37 were in the experimental group and 16 were in the control group. Those in the experimental group were then randomly assigned to either a resistance-(n=19) or an endurance-(n=18) training exercise group (see Appendices I and J). Participants were instructed to practise 'normal' eating habits and to refrain from commercial diets for the duration of the study.

Those in the exercise groups returned a third time to participate in a 1-mile walking test which provided an estimation of aerobic fitness (Kline et al., 1987). The two exercise programs began in the second week of September and ran for a duration of three months, at which time, all participants returned for the post tests.

Throughout the study, effort was made to communicate with all participants by way of telephone contact, handouts/notices, and letters in the mail in order to address concerns and monitor any problems that participants may be experiencing.

3.4 DEPENDENT MEASURES

Four major variables related to weight management were measured. Subjects had all of the same tests done pre- and post- exercise training program. Pre- and post-treatment measurements included:

3.4.1. Metabolic Rate (REE)

All subjects, with the exception of two who walked slowly from campus residence, arrived by motor vehicle at the Allan McGavin Sports Medicine Centre. Subjects were encouraged to drive or get a ride to the Centre as any activity has been shown to elevate true REE values (Berke et al, 1992). With the exception of water, they were instructed to not eat or drink during the 12 hours preceding their metabolic test. They were also instructed to not exercise in the 24 hours preceding their test. Participants were phoned the night before to remind them of these instructions.

After lying on a cot for 30 minutes, they practised breathing through a mouthpiece and hose attached to a metabolic cart until they felt comfortable with the apparatus. Air samples were collected and analyzed for the next 20 minutes by a CAD/NET System 2001 Metabolic Cart (Medical Graphics Corp. St. Paul, MN). This equipment is reliable to

+/- 5% based on laboratory pilot tests for REE tests done under standard conditions. Resting energy expenditure was calculated from values for oxygen consumption and carbon dioxide production using the Weir (1949) equation:

$$\text{REE (kcal/day)} = \\ (3.941 \times \text{VO}_2 \text{ ml/min}) + (1.106 \times \text{VCO}_2 \text{ ml/min}) \times 1.44$$

Metabolic tests were administered between 7 a.m. and 10:30 a.m. in the morning during the follicular phase of the menstrual cycle (days 0 to 14 after menses begins) to control for REE periodicity which coincides with the menstrual cycle (Bisdee, James, & Shaw, 1989; Meijer, Westerterp, Saris, & ten Hoor, 1992; Solomon, Kurzer, & Calloway, 1982; Webb, 1986). It has been shown that 24-hour energy expenditure may increase by 9% in the post-ovulation or luteal phase (Webb, 1986).

3.4.2. Body Composition

Skinfold measures (Ross & Marfell-Jones, 1991) using Slimguide calipers (Creative Health Products, 5148 Saddle Ridge Rd., Plymouth, MI 48170) were taken on the right side of the body with the exception of the abdominal fold, which was measured on the left side. Measurements

were taken at 8 different sites (biceps, triceps, subscapular, iliac crest, supraspinale, front thigh, medial calf). Skinfold readings give indirect measures of subcutaneous fat quantity and distribution.

Measures on all participants were repeated 3 times by a single trained observer who had a test-retest reliability of .99 and .95 for the bicep and tricep skinfold respectively. The average of the 3 measurements at each site was calculated. If the first 2 values at a particular site were the same, a third measurement was not taken. Measurements with this technique are accurate within +/- 5% (Durnin & Rahman, 1967). The Anthropometric Measurement Form used to record measurements is shown in Figure 4.

ANTHROPOMETRICS					
Name:			Number:		
Date:			Technician:		
Birth Date			Age:		
Height (cm):		Weight (kg):		BMI:	
Measures	1	2	3	record	comments
SKINFOLDS					
Biceps					
Triceps					
Subscapular					
Iliac Crest					
Supraspinale					
Abdominal (vert)					
Front Thigh					
Medial Calf					
GIRTHS					
Upper Arm					
Forearm					
Waist					
Hip					
Thigh					
Calf					

Figure 4. Anthropometric Measurement Form

Body density was determined using a generalized regression equation derived for women varying in age and body composition (Jackson, Pollock, & Ward, 1980). This equation uses the sum of four skinfolds (triceps, iliac crest, abdominal, and thigh), hip circumference or girth, and age to determine body density:

Body density (g/ml) =

$$1.1454464 - 0.0006558 (\text{sum of triceps, vertical abdominal, iliac crest, thigh in mm}) + 0.0000015 (\text{sum of 4 skinfolds})^2 - 0.0000604 (\text{age in years}) - 0.0005981 (\text{hip girth in cm})$$

$r = .862$

Percent fat was derived from body density using Siri's (1961) equation:

% fat =

$$(4.95/\text{Density} - 4.5) \times 100$$

Fat mass was calculated by multiplying body mass times percent fat, and fat-free mass was then calculated by subtracting fat mass from body mass.

Girth measurements were also taken. According to standard procedures (Ross & Marfell-Jones, 1991), measurements were obtained at 6

different sites (upper arm, forearm, waist, gluteal/hip, thigh, calf) using a Lufkin retractable metric measuring tape.

3.4.3 Dietary Intake

Subjects recorded three-day diet records, which included 1 weekend day and 2 weekdays. Because food intake may increase during the luteal phase of the menstrual cycle (Dalvit, 1981; Gong, Garrel, & Calloway, 1989; Pliner & Fleming, 1983; Tarasuk & Beaton, 1991), food records were taken during the follicular phase of the cycle. It has been shown that total dietary intake may increase from 100 (Tarasuk & Beaton, 1991) to 500 (Dalvit, 1981) kcal per day in the luteal phase. Particular emphasis was placed on the importance of maintaining typical eating habits and describing foods and methods of preparation in detail. Food models to denote size, density, and volume were shown as examples of servings. Those who had weighing scales for food were encouraged to use them. Participants were encouraged to deliver their diet records at the time of their metabolic tests. However, they were also given pre-addressed envelopes to mail in their completed diet records. All records were checked for accuracy with the subjects. The Food Processor II version 3.0 series nutrition analysis system (ESHA Research, copyright 1988-1990, Salem, OR) based on the American Recommended Dietary Allowances (RDA) was used to analyze dietary intakes.

At the midpoint of the intervention, participants in the exercise programs were given an interim diet assessment which included two questions about their dietary habits: 1) We assessed your diet at the beginning of the study. Do you feel that your dietary intake is about the same as then?, and 2) If 'no', please explain what has changed since your first diet record (see Appendix N). The interim diet assessment was done to evaluate whether or not dietary intake had changed during the first half of the study.

3.4.4 Eating Behaviour

While there is extensive research in the area of exercise, energy intake and dietary composition, few studies have examined exercise and specific aspects of eating behaviour. Subjects were administered the Three-Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985). This 51 item questionnaire measures cognitive restraint of eating (21 items), disinhibited eating (16 items), and susceptibility to hunger (14 items). This questionnaire has been extensively tested for both validity and reliability (Stunkard & Messick, 1985).

Restrained eating refers to concern about, and conscious control of eating behavior; disinhibition refers to the tendency toward periodic loss of control of eating behaviour and the tendency to relieve emotional states by eating; hunger refers to the subjective sensation of

hunger (Weissenburger et al., 1986). It is suggested that restrained eaters place themselves in a state of physiological and psychological deprivation which cannot be maintained and ultimately leads to pathological overeating or disinhibited eating (Kirkley et al., 1988). There is little existing literature on the effects of exercise on these three constructs. The research in this area was of an exploratory nature.

3.4.5 Other

In addition to the above measurements, pertinent information including height, weight, date of menses, and use of oral contraceptives was obtained. Subjects in the exercise intervention participated in a one-mile walking test (Kline et al., 1987). This field performance test evaluates aerobic fitness and provided an estimation of baseline aerobic fitness level for the two experimental groups. The test required only fast walking which made it useful for testing sedentary participants. Subjects were instructed to "walk as fast as you can", and they were timed as they completed a one-mile pre-measured outdoor course. Maximum oxygen uptake ($\text{VO}_2 \text{ max}$) was calculated using the equation developed by Kline et al:

$$\begin{aligned} \text{VO}_2 \text{ max (l/min) =} \\ & 6.9652 + (0.0091 \times \text{weight in lbs}) - (0.0257 \times \text{age in years}) \\ & + (0.5955 \times \text{sex [0=female; 1=male]}) - (0.2240 - \text{time to walk 1 mile in} \\ & \text{mins}) - (0.0115 \times \text{HR in bpm}) \end{aligned}$$

This equation has a reliability of .93 and a validity of $r=.92$ when validated against a treadmill protocol (Kline et al., 1987). All participants were mailed out the results of the pre and then the post tests as well as an explanation of what the measurements meant (see Appendices K, L, and M).

3.5 EXERCISE INTERVENTION

After completion of pre tests, subjects in the treatment groups participated in a 3-month exercise program. Exercise in both the endurance- and the resistance-training groups were of a moderate intensity in order to minimize potential injury and maximize compliance (Pollock & Wilmore, 1990). Classes began simultaneously in September of 1992 and were scheduled 3 days per week from 5-6 pm. Sessions were limited to 60 minutes, as programs lasting longer than this time are associated with higher dropout rates (Pollock, 1988).

Classes were taught by certified fitness instructors and the research investigator was present at every class to take attendance and address concerns. Effort was made to hire instructors with health-related backgrounds as this has been shown to have a positive effect on exercise adherence (Gillett, 1988). One instructor had a Masters Degree in Physical Education, one had a Bachelor of Science in Kinesiology and Dietetics, and the other was a fourth year Dietetics student.

Participants were encouraged to exercise one weekend day on their own to train themselves to do independent exercise. However, this recommendation was not a criteria for completion of the study. Sixty-six per cent of their exercise had to be supervised in order for subjects to be included in the final analyses. This meant that they had to attend an average of at least two out of three classes per week as determined by attendance records. Participants were also instructed to make up for classes missed during the week on their own time. Exercise log books were used to record both supervised and unsupervised exercise, as well as heartrate values, date of menses, and any unusual changes in eating habits. Appendix O depicts the handout given to participants describing the information to record in the logbooks. The practice of self monitoring and record-keeping has been shown to be a factor which encourages adherence (Dishman, 1988; Holden, Darga, Olson, Stettner, Ardito, & Lucas, 1992). Participants were contacted by telephone on a

regular basis to receive their suggestions on how changes in the classes would help their adherence.

3.5.1 Endurance Training

The endurance program took place on an outdoor track approximately 1 km from the centre of the university campus. Because the track was not lit, participants were given arm reflectors to help them identify each other as the evenings became shorter and darker. Based on a previous walking program (Bergman & Boyungs, 1991), the endurance treatment included 10 minutes of warm-up exercises, a walking component, and a 10 to 20 minute cool-down (see Table 1).

Within a defined moderate intensity (Pollock & Wilmore, 1990), the walking component progressed from 20 to 40 minutes at a rate that elevated individuals' heart rates from 60% to 80% of their maximum heart rates. Participants were made aware of this goal. Research shows that goal setting is an important aspect of an exercise program (Anthony, 1991; Dishman, 1988; Gillett, 1988; Martin et al., 1984; Perkins, Rapp, Carlson, & Wallace, 1986). Target heart rate zones were calculated for each individual. Maximum heart rate was calculated by subtracting current age in years from 220 (Fox, Naughton, & Gorman, 1972). This meant that on average, participants in this group were exercising within

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a heart rate range of 103 and 156 beats per minute or between 17 and 26 beats per 10 seconds. Heart rate checks were taken twice during the walking component of each class.

Table 1**Exercise Program: Endurance-training Group**

	Warm-up and Pre-Cardio (min.)	Walking (min.)	Cool-down/ Stretch (min.)	Total (min.)
Week 1,2	10	20	20	50
Week 3,4	10	25	20	55
Week 5,6,7,8	10	30	20	60
Week 9,10	10	35	15	60
Week 11,12	10	40	10	60

Two heart-rate checks done per class:

Participants should be between 60% and 80% of their maximum heart-rate

ie. if 25 years old

20-26 beats per 10 secs

if 49 years old

17-23 beats per 10 secs

3.5.2 Resistance Training

The resistance program took place in an indoor room not far from the centre of campus. The resistance-training program included a 10 to 20 minute warm-up, a toning component, and a 10 minute cool-down (see Table 2).

The 'toning' component progressed from a 20 to 40 minute period. Again, participants were made aware of this desired progression. Based on recommendations by the American College of Sports Medicine (Position Stand, 1990), the toning component included at least 1 set of 12 repetitions of 10 exercises that conditioned major muscle groups. The exercises involved major muscle groups because movement of these muscles has a moderate to high energy cost, especially those muscles of the leg (Katch et al., 1991). In order to incorporate both upper and lower body exercises, the major muscle groups chosen by investigators for this study were biceps, triceps, pectorals, latissimus dorsi, abdominals, gluteals, quadriceps, hamstrings, outer thigh, and inner thigh.

Generally, progressive resistance-training programs start with a light weight load and many repetitions (12-15) and, over time, involve a gradual decrease in the number of repetitions while increasing the weight load (Katch et al., 1991). Participants were supplied with 2 lb hand-weights which they had to bring with them to each class. These

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weights were used with increased difficulty as time progressed. With the exercise instructor leading the pace, the classes proceeded from resistance exercises without weights, to more exercises involving a weight in each hand, to exercises involving the use of both weights in each hand where possible. This seemed the best possible way to simulate a progressive resistance-training program given the population and the available facilities.

Table 2**Exercise Program: Resistance-training Group**

	Warm-up (min.)	Toning (min)	Cool-down/ Stretch (min)	Total (min.)
Week 1,2	20	20	10	50
Week 3,4	20	25	10	55
Week 5,6,7,8	20	30	10	60
Week 9,10	15	35	10	60
Week 11,12	10	40	10	60

Major Muscle Groups:**Upper Body**

Biceps
Triceps
Pectorals
Latissimus Dorsi
Abdominals

Lower Body

Gluteals
Quadriceps
Hamstrings
Outer Thigh
Inner Thigh

3.6 DATA ANALYSES

Three of the four major constructs, body composition, dietary intake, and eating behaviour were divided into sub-variables which could be measured. Body composition was measured as fat-free mass and sum of skinfolds. Dietary intake was measured as total energy, percent energy from carbohydrate, and percent energy from fat. Eating behaviour was measured as cognitive restraint of eating (Factor 1), disinhibited eating (Factor 2), and hunger (Factor 3). Table 3 shows the graphical representation of the four constructs and their sub-variables.

Body composition, dietary intake, and eating behaviour were analyzed by multivariate analyses of variance (MANOVA) procedures. MANOVAs are appropriate for analyzing sets of measures which represent underlying constructs (Bray & Maxwell, 1982). Also, MANOVAs make it possible to reduce the total number of dependent variables (in this case, $n=8$) to smaller sets ($n=3$) (Bray & Maxwell, 1982). Resting energy expenditure was the one value used to represent metabolic rate, and it was analyzed by analysis of variance (ANOVA) procedures.

•

Table 3**Breakdown of Dependent Variables**

Metabolic Rate	Body Composition	Dietary Intake	Eating Behaviour
REE	Fat-free mass (FFM)	Total Energy (Total)	Restraint (F1)
	Sum of Skinfolds (Sum SF)	Carbohydrate (% CHO)	Disinhibition (F2)
		Fat (% Fat)	Hunger (F3)

A 3 (Group) x 2 (Time) ANOVA with repeated measures on the second factor was performed on metabolic rate. A 3 (Group) x 2 (Time) MANOVA was performed on each of body composition (sum of skinfolds and fat-free mass treated as a single construct), dietary intake (total energy, % carbohydrate, and % fat treated as a single construct), and eating behaviour (Factor 1, Factor 2, and Factor 3 treated as a single construct). With alpha set at .05, only the interactions were tested in order to determine whether exercise modality had a differential effect among the groups. Significant MANOVA results were followed up by protected univariate statistics on the dependent variables. (Using the Bonferonni adjustment, the experiment-wise alpha of the overall MANOVA was divided by the number of dependent variables in the follow-up univariate analysis.) This is considered an appropriate post hoc procedure for MANOVA (Bray & Maxwell, 1982; Hertzog & Rovine, 1985; Schutz & Gessaroli, 1987). Pre-planned orthogonal contrasts helped explain significant differences. These contrasts were set to compare exercise versus no exercise (endurance and resistance versus control) and the two exercise groups (endurance versus resistance).

A 3 (Group) x 2 (Time) ANOVA with repeated measures on the second factor was also performed on body weight, BMI, and waist-to-hip ratio (WHR), and a 2 x 2 ANOVA on maximum oxygen uptake (VO₂ max). Again, with alpha set at .05, only the interactions were tested.

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All data were analyzed using BMDP 2v and 4v statistical software for the mainframe. Normality boxplots were run on each of the nine variables using SPSS-X Release 3.0 for IBM-MTS.

CHAPTER 4

RESULTS AND DISCUSSION

Following the three-month intervention period, participants in the two exercise groups were invited to attend a 'wrap-up' party where a slide show, snack food, and draw prizes were provided. The purpose of this final group meeting was to answer any questions/concerns and to give participants a chance to discuss the possibilities of continuing the exercise classes as a group.

During the post-testing period, both exercise groups were given a brief and informal questionnaire aimed at participants' feedback regarding the program (see Appendix P). This questionnaire addressed: 1) factors influencing continuation and completion of the program; 2) factors that could have been improved; and 3) future plans concerning exercise.

4.1 ATTRITION

A total of 83 volunteers expressed an interest in the study and appointments were scheduled. Of these, 72 came for their initial visit. Twelve did not meet the inclusion criteria (1 had an eating disorder, 8 had BMI's < 25, and 3 had BMI's > 33). Another 7 participants withdrew from the study after their initial visits.

Fifty-three participants completed all pre tests. Before randomization, a total of 45 were interested in the exercise program. Subsequently, 8 people switched to the control group for various reasons which included job interference and distance from campus. The exercise intervention began the second week of September. Exercise participants were randomly assigned to either the endurance group (n=18) or the resistance group (n=19). For reasons explained previously, the control group (n=16) had been recruited separately.

Of the endurance group, 7 did not complete the study. Reasons for attrition included: 1) Stress fracture due to factors unrelated to exercise (n=1); 2) hospitalization (n=1); 3) absenteeism (n=3); 4) job interference (n=1); and 5) chronic fatigue syndrome (n=1). Therefore, once randomized, numbers in the endurance group dropped from 18 to 11.

RESULTS AND DISCUSSION

Of the resistance group, four did not complete the study. Reasons for attrition included: 1) personal problems (n=1); 2) job interference (n=2); and 3) absenteeism (n=1). Therefore, once randomized, numbers in the resistance group dropped from 19 to 15.

Of the control group, four did not complete the study. Reasons for attrition included: 1) a misunderstanding of the study (n=1); 2) an unexpected move to Washington, DC (n=1); 3) distance from UBC too far (n=1); 4) embarrassment (n=1). Therefore, the numbers in the control group dropped from 16 to 12.

A total of 41 participants completed the study. The endurance group experienced a 39% dropout rate (final n=11) and the resistance group experienced a 21% dropout rate (final n=15). Those who dropped out of the exercise groups within the first week of classes for reasons related to job interference were asked to be in the control group. As a result, the control group, which experienced its own dropout rate of 25%, ended up with a final sample size of 15.

Having too small a sample size to run MANOVAs was an initial concern. However, for MANOVA, it is recommended that the minimum total sample size be $[p(k-1) + j]$, where p is the number of dependent variables per MANOVA (largest $p=3$) measured under each of the k repeated observations, and j is the number of groups, thus $N \geq 6$, or that the

minimum number of subjects per group must exceed the total number of observations per subject per MANOVA (pk) (Schutz & Gessaroli, 1987). That is, the smallest group size, $n=11$, must exceed the number of dependent variables per MANOVA (largest $n=3$) multiplied by the number of observations ($n=2$ for pre versus post), thus $11 > 6$ (Schutz & Gessaroli, 1987). The sample size of this study met these criteria.

4.2 RESULTS OF THE DATA ANALYSES

The means and standard deviations of the 9 dependent variables, pre and post are depicted in Table 4.

Table 4
Mean Scores for the Dependent Variables Pre and Post

Pre		REE	FFM	SumSF	Total	%CHO	%Fat	Factor 1	Factor 2	Factor 3
Endurance										
	<u>M</u>	1465	45.5	283.0	1800	50.7	31.2	6	11	8
	<u>SD</u>	158	3.5	40.1	531.1	6.0	3.5	4	3	4
Resistance										
	<u>M</u>	1413	45.3	287.5	1932	49.1	35.0	9	11	7
	<u>SD</u>	156	3.1	43.2	498.7	8.6	8.4	4	4	4
Control										
	<u>M</u>	1422	45.8	316.4	1883	51.1	32.3	10	11	7
	<u>SD</u>	150	3.8	58.5	596.0	8.3	6.9	4	3	4
Post		REE	FFM	SumSF*	Total	%CHO	%Fat	Factor 1	Factor 2	Factor 3
Endurance										
	<u>M</u>	1453	46.9	234.2	1704	49.0	34.0	8	9	5
	<u>SD</u>	194	3.2	42.0	327.2	6.0	6.2	5	3	3
Resistance										
	<u>M</u>	1425	47.5	230.4	1815	52.4	31.6	10	9	6
	<u>SD</u>	112	3.7	41.5	506.1	7.3	6.6	5	4	4
Control										
	<u>M</u>	1412	46.7	315.9	1811	47.6	34.5	9	9	6
	<u>SD</u>	172	4.2	61.4	688.6	5.1	4.9	4	3	4

Note. Units of measurement are: REE (kcal expended/day); FFM (kg); SumSF (sum of biceps, triceps, iliac crest, subscapular, supraspinale, abdominal, thigh, medial calf - in mm); Total (kcal ingested/day); %CHO (% of Total); % Fat (% of Total); Factor 1 (maximum score =21); Factor 2 (maximum score = 16); Factor 3 (maximum score = 14).

*p < .001, interaction only

A summary of the MANOVA and ANOVA results is shown in Table 5.

Table 5

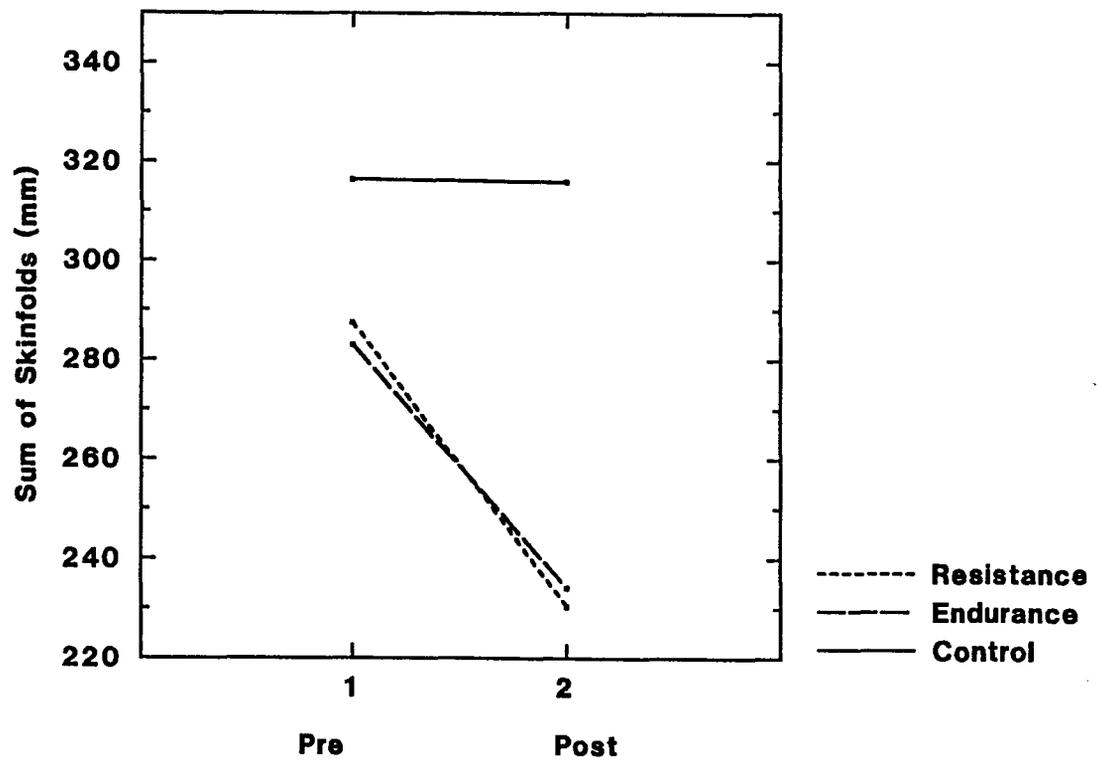
MANOVA and ANOVA Summary Table: Group by Time Interaction Only

Source	SS	df	MS	F	p
Metabolic Rate	2546.14	2,38	1273.07	0.16	0.8512
Body Composition	-----	4,74	-----	6.79	0.0001
SumSF	13583.94	2,38	6791.97	16.28	0.0000
FFM	5.05	2,38	2.53	1.89	0.1656
Dietary Intake	-----	6,72	-----	1.48	0.1957
Eating Behaviour	-----	6,72	-----	0.62	0.7138

The 3 x 2 ANOVA on metabolic rate was not significant at the .05 level, $F(2,38)=0.16$, $p=0.8512$. There was no significant difference between the three groups over time for this variable.

RESULTS AND DISCUSSION

The overall MANOVA test on body composition was significant, multivariate $F(4,74)=6.79$, $p=0.0001$, thus indicating that the three groups differed over time on at least one of the dependent variables. The univariate follow-up F test was significant for sum of skinfolds, $F(2,38)=16.28$, $p<.0001$ (see Figure 5) but not significant for fat-free mass, $F(2,38)=1.89$, $p=0.1656$. Pre-planned contrasts indicated a significant loss of skinfolds for the two exercise groups relative to the control group, $F(1,38)=31.01$, $p<.0001$. There was no significant difference between the two exercise groups for this variable, $F(1,38)=0.51$, $p=0.4796$.



Calculated F with 2 and 38 degrees of freedom = 16.28, $p < 0.0001$

Figure 5. Sum of Skinfolds: Group x Time Interaction

RESULTS AND DISCUSSION

The overall MANOVA test on dietary intake was not significant, multivariate $F(6,72)=1.48$, $p=0.1957$. There was no difference between the three groups over time on total energy ingested, percent energy from carbohydrate, or percent energy from fat.

The overall MANOVA test on eating behaviour was not significant, multivariate $F(6,72)=0.62$, $p=0.7138$. There was no difference between the three groups over time on Factor 1, Factor 2, or Factor 3.

Table 6 depicts age and physical characteristics of the three groups.

Table 6
Age and Physical Characteristics

		Pre				Post			
	Age	Wt	BMI	WHR	VO2	Wt*	BMI*	WHR	VO2**
Endurance									
<u>M</u>	42.2	74.5	27.8	0.81	2.42	73.9	27.6	0.79	2.68
<u>SD</u>	6.5	7.1	1.8	0.06	0.39	8.2	2.0	0.05	0.26
Resistance									
<u>M</u>	37.4	75.1	28.0	0.77	2.48	75.2	28.0	0.76	2.62
<u>SD</u>	7.4	7.0	1.7	0.05	0.33	9.1	2.5	0.05	0.32
Control									
<u>M</u>	40.7	78.9	28.5	0.77	—	81.4	29.3	0.77	—
<u>SD</u>	6.8	8.6	2.7	0.04		9.7	3.3	0.05	

Note. Units of measurement are: Age (years); Body Weight (kg); Body Mass Index (kg/m²); Waist to Hip Ratio (cm);

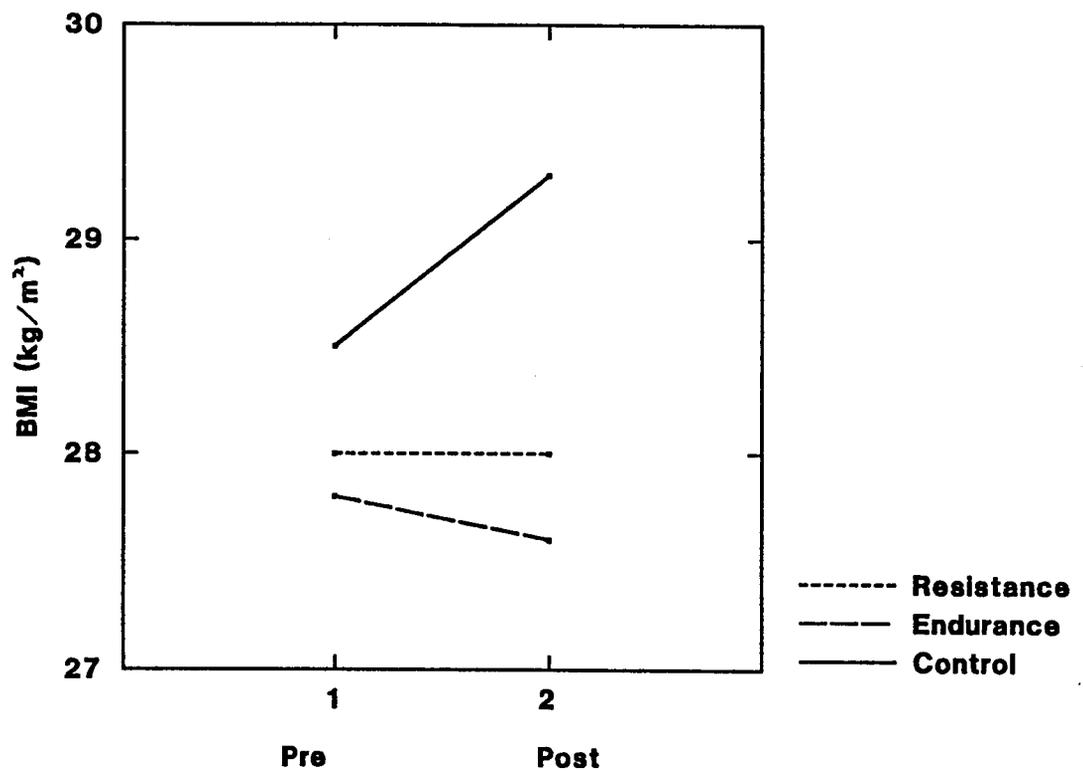
Maximum volume of Oxygen uptake (l/min) determined by a one-mile walking test (Kline et al., 1987)

*p < .05, interaction only

**p < .05, time effect only

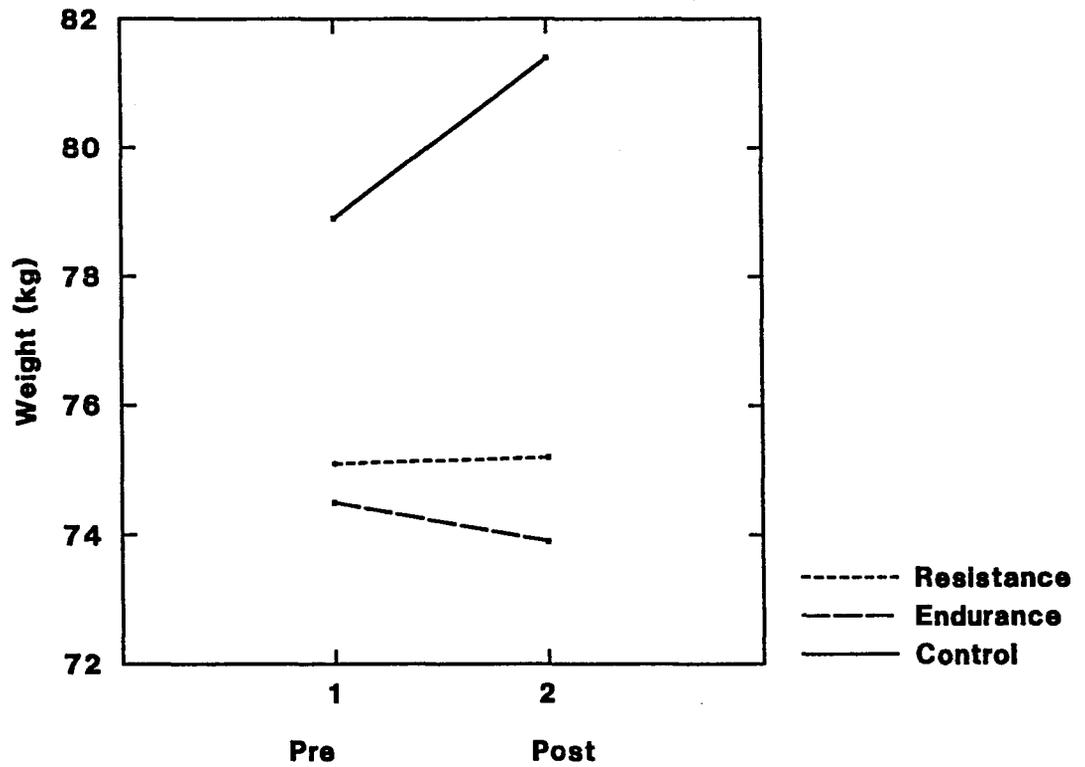
RESULTS AND DISCUSSION

Of the physical characteristics, the interaction for BMI was significant, $F(2,38)=3.32$, $p=0.0468$, due to an increase in weight for the control group relative to the two exercise groups, $F(2,38)=3.86$, $p=0.029$ (see Figures 6 and 7).



Calculated F with 2 and 38 degrees of freedom=3.32, $p=0.047$

Figure 6. Body Mass Index: Group x Time Interaction



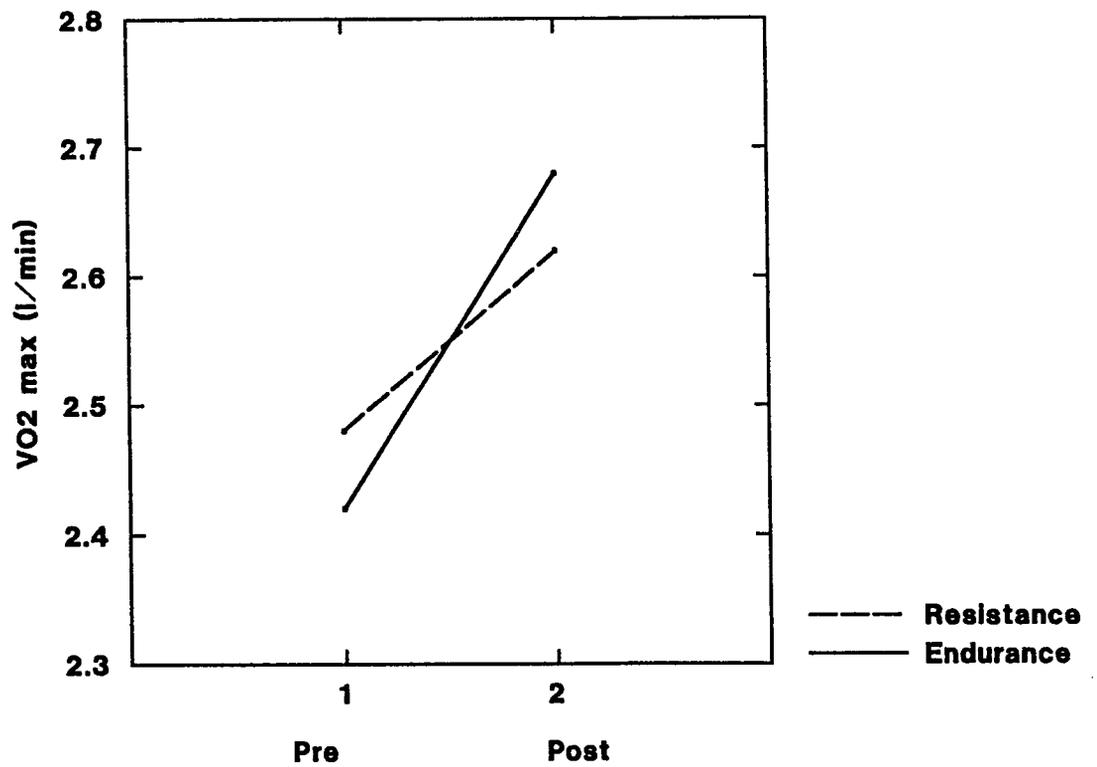
Calculated F with 2 and 38 degrees of freedom=3.86, $p=0.029$

Figure 7. Weight: Group x Time Interaction

The interaction for WHR was not significant, $F(2,38)=1.35$, $p=0.2714$. There was no significant interaction for maximum VO_2 for the

RESULTS AND DISCUSSION

two exercise groups, $F(1,21)=0.63$, $p=0.4375$, but there was a significant time effect, $F(1,21)=7.59$, $p=0.0119$ indicating that both groups experienced an increase in maximum VO_2 over time (see Figure 8).



Calculated F with 1 and 21 degrees of freedom = 7.59, $p=0.012$

Figure 8. Maximum Oxygen Uptake: Time Effect

RESULTS AND DISCUSSION

The responses to the three questions of the Exercise Adherence Questionnaire are depicted in Figures 9, 10, and 11. Figure 9 shows the responses out of 26 to the question 'In your opinion, what factors influenced your continued participation and completion of the program?'. Figure 10 shows the responses out of 26 to the questions 'What factors could be improved?', and Figure 11 shows the responses to the question 'Will you continue exercising in the same manner? If no, what will be modified?'.

Exercise instructor was most frequently reported (n=16) as a positive factor influencing continuation and completion of the program. Timing of the classes was cited most often (n=6) as a factor that could have been improved. Some participants felt the classes should have been scheduled earlier in the day while others felt they should have been scheduled later. The majority of participants (n=20) reported they would continue to exercise in the same manner as that followed in the classes.

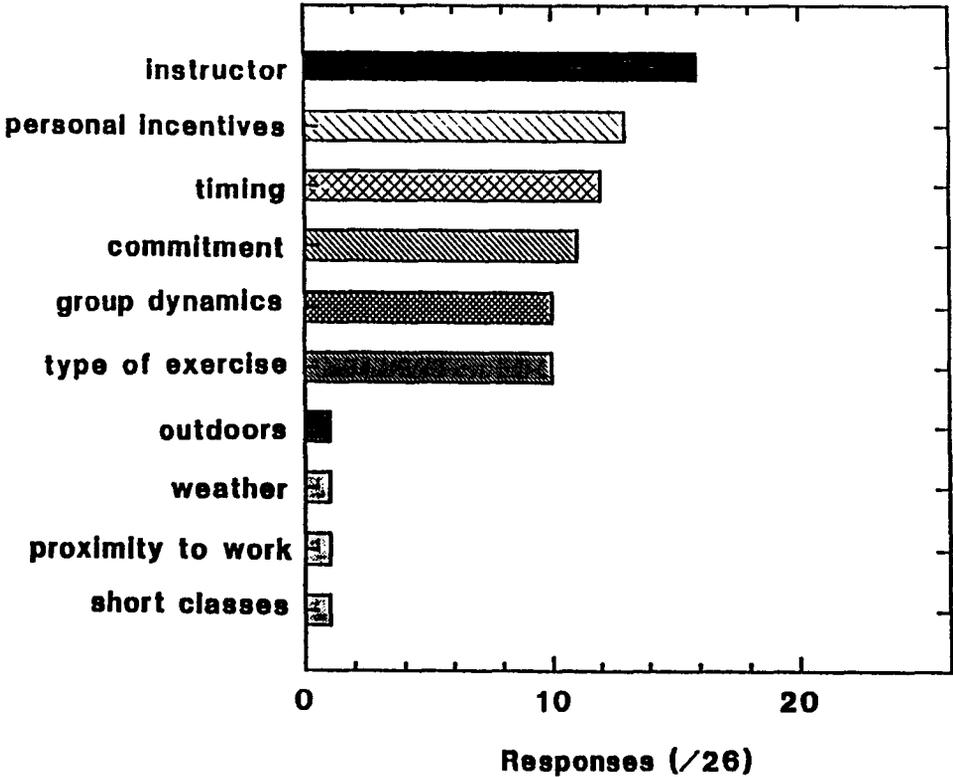


Figure 9. Exercise Adherence Questionnaire: Perceived Positive Factors Influencing Completion

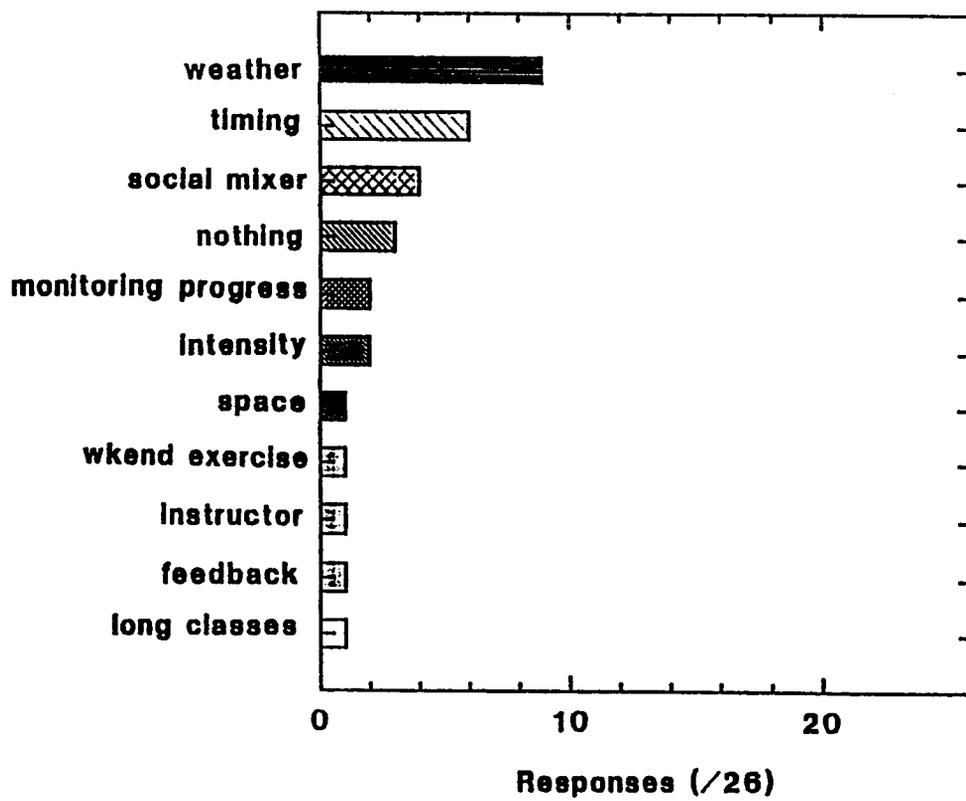


Figure 10. Exercise Adherence Questionnaire: Perceived Factors that Need Improvement

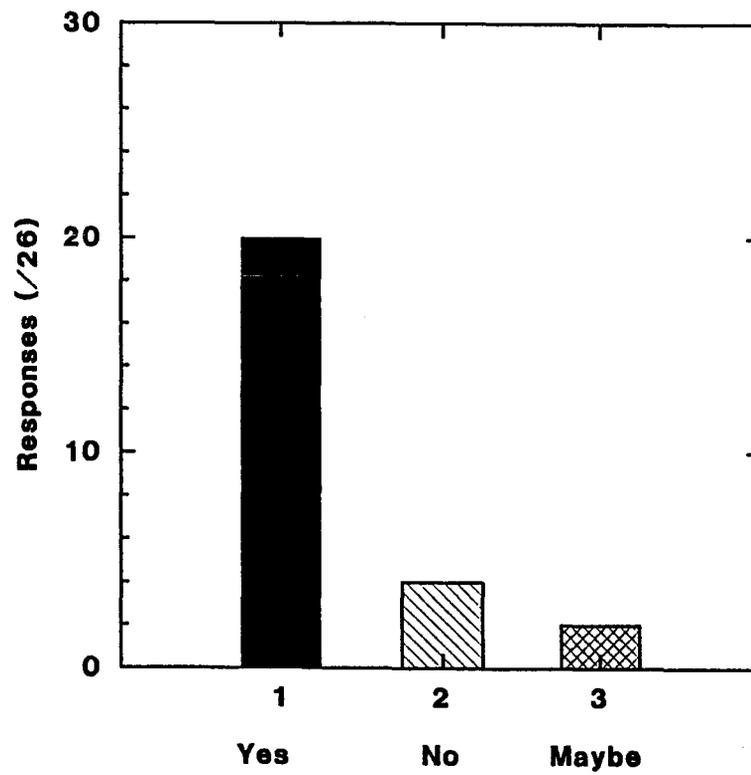


Figure 11. Exercise Adherence Questionnaire: Will you Continue to Exercise?

4.3 DISCUSSION

The purpose of this project was to assess the effects of exercise modality on metabolic rate, body composition, dietary intake, and eating behaviour in overweight women and to discuss implications for future study concerning exercise prescription, exercise adherence, and effective weight management.

4.3.1 Metabolic Rate

At the time of the study's conception, it was widely speculated that chronic dieting led to permanent metabolic alterations which promoted weight gain and made subsequent loss of weight more difficult. This premise is now being questioned. It is presently thought that the effects of chronic dieting are temporary, lasting only until 'normal' eating habits are resumed (Melby, Schmidt, & Corrigan, 1990). However, this is a relatively new finding and it still concurs with the fact that chronic dieting depresses REE.

According to the Harris - Benedict equation (1919), it was shown that, on average, all participants had lower REE's than predicted by sex, age, height, and body mass ($1429 \text{ kcal/d} < 1490 \text{ kcal/d}$, $t=-4.037$, $p<0.0001$). The Harris-Benedict equation is used widely by nutritionists

and physiologists to predict REE. It appears then, that chronic dieting does cause a depression, even if temporary, in metabolic rate.

It was thought that an exercise intervention would reverse the effect of chronic dieting and increase REE to its original level as shown by previous research (Mole et al., 1989). Contrary to these findings, results of this study indicated that there were no changes in REE due to exercise condition or exercise itself.

It has been found that the effect on REE during non-active times varies with both the intensity and duration of exercise (Knuttgen, 1970). As previously suggested, an exercise intensity of greater than 50% VO_2 max may be required to produce significant increases in REE (Bahr et al., 1987). However, it has also been suggested that a threshold of approximately 70% VO_2 max is needed to significantly affect REE during non-active times (Brehm, 1988). Even though the participants in the endurance-training group were instructed to exercise at a rate that elevated their heart rates from 60% to 80% of their maximum heart rates, it is quite possible that they were exercising at the lower end of this range. Heart rate values recorded in the logbooks were indicative of this possibility. Overweight individuals may be unable to maintain an exercise intensity of 70% VO_2 max (Brehm, 1988). This may account for the lack of an increase in REE found in this study.

4.3.2 Body Composition

It was anticipated that there would be an increase in FFM for the resistance-trained group compared to the endurance-trained group as found in a previous study comparing resistance training to endurance training (Broeder et al., 1992b). Contrary to prediction, there was no difference between the groups due to exercise modality. In fact, all groups showed an increase in FFM equivalent to 1-2 kg over the three months ($p < 0.0001$). Seasonal increases in lean tissue over the winter period have been previously observed in healthy post-menopausal women (Dawson-Hughes & Harris, 1992). The reasons for this trend are unclear.

It has been suggested that a change in body composition is proportional to the frequency and intensity of exercise (Epstein & Wing, 1980). Although participants exercised three to four times per week, the use of 2 lb hand-weights in the resistance-training component may have been insufficient to cause significant changes in FFM relative to the endurance and control groups. Previous studies with a resistance-training component (Ballor et al., 1988; Broeder et al., 1992b) have incorporated rigid routines using Nautilus and Universal gym weight systems. Such equipment makes it easier to monitor individual training with respect to specific muscle development and it allows researchers to

progressively increase resistance over time. Such monitoring was not possible in this study.

According to Jones (1992), muscle hypertrophy occurs relatively slowly and requires several years of exercise before an obvious increase in size occurs. It is unclear how much of an increase constitutes 'obvious' to this researcher. Although previous studies have found increases in FFM over a relatively short time period, in as little as two to three months (Andersson et al., 1991; Ballor et al., 1988; Bergman & Boyungs, 1991; Broeder et al., 1992b; Keim et al., 1990), these increases may not be meaningful. All of these studies except one involved overweight individuals and all found statistically significant 'exercise-induced' increases in FFM ranging from 1-2 kg. Although different equations to determine FFM must be accounted for, the present study also found increases ranging from 1-2 kg. However, this increase was independent of exercise and exercise condition. If an increase of 1-2 kg of FFM can occur in the absence of exercise, this may not constitute an 'obvious' increase. If an 'obvious' increase means that it is sufficient to subsequently increase REE, then 2 kg may not be enough. Of the above studies concerning FFM, Broeder et al.'s (1992b) study was the only one which looked at both FFM and REE. These researchers found a 2 kg increase in FFM in individuals undergoing resistance training, but no change in REE for these individuals.

Similarly, the present study found a 1-2 kg increase in FFM for all groups but no change in REE.

Exercise, regardless of modality, did have a significant effect on sum of skinfolds. Both exercise groups experienced a loss of skinfolds equivalent to approximately 2-4% fat compared to the control group. These results are similar to the results of a recent cross-sectional study comparing resistance- and aerobically-trained women. Ballor and Poehlman (1992) found that both endurance- and resistance-trained groups had less total percent body fat and subcutaneous fat than did sedentary women, but that differences between the two exercise groups were not observed.

4.3.3 Dietary Intake

Results indicated no differences among the groups for total energy intake or for diet composition. This is consistent with the majority of recent research (Andersson et al., 1991; Ballor et al., 1990; Bergman & Boyungs, 1991; Broeder et al., 1992b; Keim et al., 1990; Pi-Sunyer & Woo, 1985; Staten, 1991; Thompson et al., 1988). Also, responses by those in the experimental groups to the interim diet assessment indicated that participants on average had not changed their dietary intakes at the midpoint of the exercise program.

The results pertaining to dietary intake showed a very high variability of the data. In both the pre and post conditions, the assumption of normality was violated for each of the variables: total energy, percent carbohydrate, and percent fat. The assumption of homogeneity (variance-covariance) was also violated (calculated F with 72 and 3339 degrees of freedom=1.64, $p=0.001$), indicating that the variability among the groups was different. It may be that the high variability of the data accounts for a lack of significant differences among the groups.

It is possible that the act of recording food intake may have influenced dietary habits on monitored days. Also, there are factors affecting food intake other than exercise itself which could not be controlled for. These included exercise motivation, age, temperature of the environment, light/dark hours, and season of the year (Titchenal, 1988). Perhaps, these factors, especially environmental temperature, light/dark hours, and season of the year, interacted with dietary intake over the three months.

4.3.4 Eating Behaviour

Exercise modality had no effect on cognitive restraint, disinhibited eating, or hunger ratings. To our knowledge, this is the first study to examine the effects of exercise on these three factors.

4.5 LIMITATIONS OF THE STUDY

1) Although subjects in both the exercise and control groups were instructed to restrain from dieting and encouraged to maintain 'typical' eating patterns, it was not possible to ensure that this request was followed. Dietary intakes from the three-day records appeared to meet their requirements, however, the dieting history of participants and the nature by which dietary information was gathered may have confounded 'typical' intakes. Participants may have simply chosen to record dietary intake on a 'typical' day, or they may have chosen to eat 'typically' on the days they recorded intakes. Also, it may be that 'typical' eating patterns are indeed highly variable for this population. It was not possible to determine whether or not participants were restricting their food intakes on a regular basis. Therefore, dieting behaviours may have interacted with the exercise conditions.

2) The assumption was made that the control group did not change their sedentary exercise patterns over the three months. This could only be confirmed verbally during the post tests. To our knowledge, only one control individual started an exercise program on her own, but she subsequently withdrew from this study.

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3) It was not possible to involve the control subjects in the 1-mile walking test so there was no comparison done between exercisers and non-exercisers of estimated VO₂ max.

4) Diet records were subject to self report, as were documentation of the days of unsupervised exercise, heartrates during class, and whether or not instructions were followed concerning no meals and no exercise 10-12 hours prior to REE testing. Subjects may have misreported their behaviours.

5) It was not possible to control for energy expenditure between the endurance and resistance exercise groups. This may have influenced the results because the energy cost of a typical resistance-training workout may be substantially lower than that of aerobic activity (McArdle et al., 1991). However, frequency and duration of the exercise sessions was kept constant. According to data from Bannister and Brown (1968), the difference in energy expenditure between the two exercise groups appears to have been minimal. Tables comparing energy expenditure in recreational and sports activities indicate that the energy expended by the endurance group may have exceeded that of the resistance-training group by only 70 kcal per session.

6) To ensure minimal dropout rates, it was important that the two exercise strategies be of reasonable intensity and duration for the

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women. It is possible that the expected changes in body composition and REE required exercise above these levels. Also, the nature of the resistance program made it almost impossible to determine whether a strict progression in the use of the weights was being carried out. Generally, progressive resistance training involves a gradual decrease in the number of repetitions while increasing the weight load (McArdle et al., 1991). This protocol was not possible with this study as only a set of 2 lb hand-weights was available for each participant. Participants progressed from resistance exercises using no weights to using both weights in each hand where possible and by increasing repetitions.

7) Although precautions were taken to minimize error in the REE and body composition measurements, the reliability and validity of these measurements are often questioned.

CHAPTER 5**SUMMARY AND IMPLICATIONS FOR FUTURE STUDY**

5.1 SUMMARY AND CONCLUSIONS

There is a high prevalence of dieting for weight loss and weight control in North America. Dieting has many negative behavioural and psychological effects such as erratic eating behaviours, guilt, low self-esteem, and depression. Dieting may also cause physiological and body composition changes such as a decrease in metabolic rate, a decrease in FFM, and an increase in fat mass that make it difficult to maintain weight loss. It was speculated that an exercise program would prove a more positive alternative to dieting as well as reverse the physiological changes such as a depressed metabolic rate often associated with chronic dieting.

Exercise may be effective for weight management and weight loss for a number of reasons. Exercise may directly increase metabolic rate through increasing the rate of protein synthesis and/or increasing the appearance of norepinephrine in circulation. These effects may result in a higher metabolic rate during non-active times and therefore an increased total energy expenditure. Exercise may indirectly increase metabolic rate due to its effects on body composition, particularly FFM.

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Fat-free mass is an important predictor of metabolic rate. The type of exercise may be important for increasing FFM. For example, research shows that resistance-training exercise is more effective at increasing FFM than is endurance-training exercise. Therefore, resistance-training exercise which results in a significant increase in FFM may subsequently increase metabolic rate thus aiding in weight management and/or weight loss.

Exercise may also have regulatory effects on food intake. While lean individuals tend to increase their dietary intake to compensate for energy lost during exercise, it has been shown that overweight individuals do not change their dietary intake in response to exercise training. Therefore, for overweight individuals, an exercise program may result in long-term negative energy balance. For reasons relating to exercise-induced depletion of muscle and liver glycogen, exercise may also lead to a higher CHO:fat intake which may have beneficial effects on weight management. The conversion of dietary CHO to stored fat in the body requires more energy than does the conversion of dietary fat to stored fat.

It was thought that the type of exercise may be important for changes in REE, body composition, and dietary intake to occur. The purpose of this thesis was to assess the effects of three exercise modalities (endurance-training versus resistance-training versus

controls or no exercise) on REE, body composition, dietary intake, and eating behaviour in overweight women and to discuss implications for future study concerning exercise prescription, exercise adherence, and effective weight management.

In conclusion, it was found that exercise modality had no effect on REE, dietary intake, or eating behaviour in this study. Exercise, regardless of modality, had a significant effect on body composition as shown by a significant decrease in the sum of skinfolds for the two exercise groups relative to the control group. In addition to decreased body fat, exercise also resulted in increased fitness level and weight maintenance for this population. Thus, although exercise modality had no effect on the variables in question, the benefits of exercise per se regarding weight management, loss of body fat, and increased fitness were observed in this population.

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5.2.1 Introduction

In general, overweight individuals, particularly women, are in need of an exercise program designed to encourage adherence and subsequent long-term weight control. The overweight woman is more

likely to drop out of an exercise program for psychological reasons such as intimidation and self-consciousness than is the 'normal' weight woman (Gillett, 1988). Also, overweight women are less willing and able to participate in strenuous activities such as those experienced in commercial fitness programs. However, exercise adherence can occur in overweight women if the program is tailored to their concerns (Gillett, 1988). Designing such a program was a major undertaking of this study. Implications regarding exercise prescription, weight management, and exercise adherence are discussed in this section.

5.2.2 Implications concerning Exercise Intensity

The intensity level of the exercise in this study was appropriate for previously sedentary women meaning that no one got injured due to the exercise and comments of over-exertion were minimal. In past studies, the complaint has been that general exercise programs have been too intense for sedentary overweight women (Pollock & Wilmore, 1990). In the present study, both exercise programs were defined as moderate. As recommended by Pollock and Wilmore (1990), individuals in the endurance group exercised at a level within 60% to 80% of their maximum heart rates. Based on recommendations of the American College of Sports Medicine (Position Stand, 1990), the resistance program included at least 1 set of 12 repetitions of 10 exercises that conditioned major muscle groups.

Probably the most important finding was that, at this level of intensity, exercise modality is not important for decreasing fat, maintaining weight, and increasing VO₂ max. At this level of intensity, the benefits of any exercise can be observed provided that it is done three times per week for one hour each session. The effect is merely the energy cost of the exercise itself and it appears that both types of exercise are equivalent in this respect.

The above findings suggest that increasing FFM and/or increasing REE is not necessary for fat loss and weight maintenance. The significant time effect for FFM but not for REE indicates that an increase of 1-2kg of FFM, which can occur in the absence of exercise, is also not sufficient to cause changes in REE. If achieving a significant increase in FFM to cause changes in REE requires an intensity level over 70% VO₂ max and/or a rigid weight-training program, such a goal may not be appropriate for a sedentary overweight population.

5.2.3 Benefits of Walking as an Exercise

Though different exercise modalities are used to achieve weight control and/or weight loss, it appears that walking may be one of the better types of exercises for sedentary overweight women. Results of the study support past claims concerning the benefits of walking as an

exercise. The endurance program, which was primarily a walking program, was as effective as the resistance training program in decreasing body fat, maintaining weight, and increasing fitness. Other researchers have found increased VO₂ max (Jette et al., 1988) and decreased body fat (Pollock et al., 1975) with walking. Psychological effects such as decreased depression and anxiety (Bahrke & Morgan, 1978) have also been associated with walking. Although there was a dropout rate of 39% in the walking group, the reasons appeared to be primarily weather-related - nine out of the final 11 participants in this group complained about weather-related factors (see Figure 10). This was the most frequently reported complaint of the program with all responses coming from the walking group. September, October, and November may not be a good time of year in Vancouver, B.C. to start an outdoor exercise program, especially if there is no alternative during inclement weather.

According to Porcari, Ebbeling, Ward, Freedson, & Rippe (1989), walking is the preferred mode of exercise for sedentary and/or moderately overweight individuals. Walking is very popular because it is simple, inexpensive, and convenient (Dishman, 1988). No equipment is needed and there is minimal risk of injury (Dishman, 1988). As indicated in the logbooks, participants in the walking group were more likely to do an extra day of exercise (walking) on their own compared to the resistance-training group. This perhaps suggests that walking may

be more beneficial than resistance training as a lifestyle intervention in an overweight sedentary population.

Another important aspect of walking for exercise is the potential for social interaction. Research shows that women's overall activity, particularly during leisure time, is positively related to family and friend support for exercise (Health & Welfare Canada, 1990a; Treiber et al., 1991). Treiber et al. (1991) have found that the consistency of relationships between social support and activity is much higher for women than for men (64% versus 31%). Figure 9 indicates that 'group dynamics', or group camaraderie, was one of the perceived factors influencing continuation and completion of the program. The majority of the 10 responses (6/10) which regarded the group as a positive influence, came from the walking group. By the end of the three months, most participants in the walking group had paired up with a "walking partner". By the end of the three months, the walking group itself had spent more time together outside of the exercise class, meeting for dinner and other social occasions. The resistance-training class did not allow for this type of interaction. In fact, four of the participants in this group complained about the lack of a social mixer (see Figure 10). The importance of social interaction as a perceived factor influencing continuation of an exercise program suggests that one way to increase exercise compliance may be to encourage participants to involve friends or significant others in their exercise programs.

Walking is also good as a 'beginner' activity. Once started, it is easy to increase the intensity or duration level (Dishman, 1988). At the end of the program, a few participants in the walking class indicated that they were going to integrate a walk-run routine. It is also possible to progress to higher energy costs with a walking routine through the addition of hand-weights (Auble & Schwartz, 1991). Therefore, walking for exercise can serve as a 'stepping stone' for other activities.

Results of the present study indicated that the effects of both the endurance and resistance-training exercise interventions were similar regarding physiological parameters such as body fat, weight, and fitness level. However, based on the literature and on some of the qualitative results of this study, walking may be preferred for practical reasons. There is very little information in the literature to support similar benefits of resistance-training exercise in sedentary overweight women.

5.2.4 Weight Management Versus Weight Gain

Results indicated that weight changes over time were different between the two exercise groups and the control group. The finding that the exercise groups maintained their weight while the control group

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gained weight over the three-month period was unexpected. If anything, one may have expected the exercise groups to lose weight and the control group to remain at its original weight. The finding that the control group gained FFM but lost no fat mass whereas the exercise groups gained roughly the same amount of FFM and lost fat mass only partially accounts for the weight discrepancy. The total amount of FFM gained in each group was about 1-2 kg but the total amount of weight gained by each individual in the control group was equivalent to about 2.5 kg or 6 lbs.

A decrease in voluntary activity may have accounted for another portion of the weight discrepancy. A recent study on obese boys found that training stimulated voluntary energy expenditure during non-exercise parts of the day (Blaak, Westerterp, Bar-Or, Wouters, & Saris, 1992). Apparently this did not occur in the present study. Perhaps, as found by Epstein and Wing (1980), participants in the exercise groups *reduced* their normal daily activities or non-exercise activities to compensate for the energy deficit associated with the exercise training. The control group, on the other hand, may have just decreased their voluntary energy expenditure over the winter period thus creating a positive energy balance which resulted in weight gain. Assumptions concerning daily voluntary energy expenditure (which was not measured) must be made because no differences were found in REE or dietary intake and eating habits among the experimental and control groups.

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Perhaps the discrepancy in weight changes was partially a result of seasonal factors. Research shows that weight fluctuation is a seasonal occurrence due to an increase in dietary intake (Hardin et al., 1991) or a decrease in physical activity accompanied by increased dietary intake over the winter period (Lee, Lawler, Panemangalore, & Street, 1987). Although no overall changes in dietary intake were observed among the groups in this study, significant increases in the control group may have been masked by the high variability of the dietary intake data.

The fact remains that the control group gained weight. This implies that, without exercise, the experimental groups would have gained an equivalent of about 6 lbs over the three month period. If weight gained is not subsequently lost in the spring/summer period, such a trend could result in long-term obesity. Therefore, it is very important that exercise be encouraged as a way of preventing this seasonal weight gain that might otherwise occur.

Results of this study indicate that exercise alone is sufficient for short-term weight maintenance. However, it is difficult to speculate whether it would result in long-term weight loss in overweight individuals. For individuals at health risk due to excess weight, it may be more beneficial to recommend a combination of exercise and diet modification in order to induce weight loss.

5.2.5 Dietary Fat Consumption

Aside from lack of dietary changes over time, the dietary habits of the women in the study deserve some discussion. According to the diet records, their energy intakes appeared normal, for example, they did not appear to exceed that of 'normal' weight individuals. This is consistent with literature findings that overweight individuals do not eat more than non-overweight individuals (Spitzer & Rodin, 1981). In fact, it has been found that overweight individuals eat fewer kilocalories (kcal) per kg body mass than do leaner individuals (Miller et al., 1990). This suggests that perhaps diet composition is one of the factors influencing weight gain.

High dietary fat intake has been found to be a strong predictor of body mass in women (Klesges, Isbell, & Klesges, 1992) and research shows that overweight individuals derive a greater portion of their energy from fat (Dreon et al., 1988; Drewnowski, Brunzell, Sande, Iverius, & Greenwood, 1985; Drewnowski & Greenwood, 1983; Drewnowski, Halmi, Pierce, Gibbs, & Smith, 1987; Schiffman, Rielly, & Clark, 1979). Taking the high variability of dietary intake into account, mean percent fat intakes were 32-33% in the present study. Although there were no changes in these intakes over time, these figures are comparable to the percent fat intakes of obese individuals in a previous study which

examined dietary composition in lean and obese adults (Miller et al., 1990). This level of fat intake does not suggest excess levels that would promote fat deposition. Presently, it is recommended that the Canadian diet should include no more than 30% of energy as fat (Health & Welfare, 1990b).

5.2.6 Factors and Behaviour Strategies for Exercise Adherence

Supervised exercise programs typically have a dropout rate of 50% (Dishman, 1988) with the majority of relapses occurring during the first several months (Dishman, 1986; Martin et al., 1984). After the first year, chances that a person will remain in such a program increase but the reasons why are largely unknown (Dishman, 1986). According to Gavin (1988), exercise prescription must be viewed as a process and not a static event. People may have different reasons for exercising and these reasons may change over time. Though information about the benefits of exercise is essential in instigating individual behaviour change, it is not by itself sufficient to support change (Health & Welfare Canada, 1987). Moreover, the initial reasons for exercise are not necessarily the same as the reasons leading to long-term adherence.

The observation that exercise behaviour is not predominantly mediated by health and fitness goals is consistent with findings of other researchers (Siegal, Johnson, & Newhof, 1988). The fact that

health and fitness-related concerns were rarely cited as perceived factors influencing continuation and completion of the program in this study confirms these findings. It may be that health concerns are a weak motivator for initiating weight-loss actions in some women because not all women define overweight as unhealthy (Laffrey, 1986). According to the 1990 Canada Health Promotion Survey, 27% of 'possibly overweight' and 19% of 'overweight' women aged 20 to 64 still rated their health as excellent (Health & Welfare Canada, 1993).

Adherence is an important aspect of any exercise program. One exercise study of overweight women which resulted in an unusually high adherence rate of 94%, reported eight participant-identified factors which influenced adherence: 1) group homogeneity with respect to age, fitness level, socioeconomic status, and sex; 2) social networks and carpooling; 3) pleasurable feelings associated with increased energy and increased fitness; 4) a leader with a health-related background; 5) time limitation of the exercise program; 6) commitment to achieve an established goal; 7) desire to change body image; and 8) desire to change health status and improve physical health problems. Although participants in the present study identified somewhat different factors influencing their completion of the program (see Figure 9), many of the aspects of Gillett's study also played a role. Group homogeneity, some degree of social networking, a leader with a health-related background, time limitation of the program, and commitment to a goal were aspects

specifically introduced by the researcher. Participants, themselves identified both the instructor and commitment to a goal as perceived factors influencing completion of the program (see Figure 9).

As mentioned previously, record-keeping and self-monitoring were also incorporated into the program to increase adherence. The logbooks appeared to provide an effective means for self monitoring/record keeping. Participants consistently recorded their attendance at class, their heartrates, start and end dates of their menstrual cycles, and 'make-up' classes. Some treated their logbooks like diaries. They included concerns about the classes, attendance at various fitness classes on the weekend and apologies for absenteeism. Four women commented that their menstrual flows had become shorter and lighter and that premenstrual cramps were almost non-existent:

"my period finally ended though experienced no discomfort with this one - usually have some";

"first day of period, no pain at all";

"I noticed this time when my period started I didn't feel sad or grumpy like I usually do".

Others made more personal comments such as:

"I feel very lethargic, did not push myself tonight";

"finding I have more energy, cardio improving";

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"I am looking forward to my classes now...have new energy after exercise class even though I have had to drag myself there before class";

"I think I am almost 'hooked' on exercising but am afraid I will fall back into my old ways if I don't join some organized exercise group";

"my one pair of pants seems to fit me more comfortably, even after being washed and dried!"

At the end of the three month period, some participants were reluctant to give up their logbooks.

Timing of the classes was cited most often as a perceived factor that could have been improved. However, it is uncertain whether changing the class times would have changed this perception and whether it would have increased exercise adherence. Lack of time in general is the most consistently reported obstacle to physical activity (Canada Fitness Survey, 1983). This complaint may simply be a rationalization rather than a reflection of reality: the observation that there is never enough time for anything is fairly common (Dishman, 1988). The problem could be a question of priorities - those who exercise regularly do not necessarily have any more time than those who do not exercise. However, interventions which provide flexible scheduling for regular exercise could be an important addition to increase adherence in exercise programs (Johnson et al., 1990).

In conclusion, the findings of this study concur with the findings of previous studies on exercise adherence. It was found that factors such as group homogeneity, a leader with a health-related background, commitment to an established goal, and social networking influence continuation and completion of an exercise program. It also appears that behaviour strategies such as time management, goal setting, record-keeping, and self-monitoring may also be helpful in increasing exercise adherence.

5.2.7 Personal Incentives

Personal incentives were also identified as factors influencing continuation and completion of the program. Responses such as:

- "the walking helped me to get out and let off some stress";
- "the fact that I did feel better and I had more energy";
- "I could notice my muscles toning about after a month so I decided that I should continue";
- "I'm trying to get used to exercise and not stopping";
- "I imagined myself as fitter and stronger and I liked that self-image";
- "I was doing it for myself largely";
- "reactions from husband and co-workers about exercise's effects on me";
- "desire to make exercise part of my lifestyle";

were cited. Approximately half of the participants reported personal incentives as perceived factors which influenced their completion of the exercise program. Although the strength of personal incentives as motivators to exercise is unclear, it may be important to recognize those individuals who need feedback concerning their appearance, their energy level, and their enthusiasm.

Enjoyment of the exercise was not reported as a perceived factor influencing adherence. According to the Canada Fitness Survey (1983), enjoyment is one of the main reasons that people give for participating in physical activity. Perhaps, for those who have no previous experience with exercise, the primary challenge for health promoters is to convince these individuals that exercise can be enjoyable.

5.2.8 Unanswered Questions

There remain many unanswered questions related to exercise and weight maintenance. For example, it has been shown that athletes of both genders have higher FFM relative to their body sizes than do sedentary peers. However, do physically active individuals also have higher REEs than sedentary individuals as a result of the exercise? Why do fluctuations in FFM occur in the absence of exercise? What is the

optimum exercise intensity to favour increases in REE that would result in a negative energy balance (Tremblay, Despres, & Bouchard, 1985)? If the intensity required to increase REE is attained, how long are the effects maintained? What is the optimum intensity and/or duration to favour changes in FFM? At what point do increases in FFM affect REE? Does an individual have to experience at least 5 kg of FFM in order to see the effects on REE? It has been shown in the present study that, at the intensity appropriate for sedentary individuals, exercise does not increase REE or FFM. If the intensity and duration required for such changes is inappropriate for sedentary, overweight individuals, it may not be worth pursuing.

5.2.9 Summary of Implications

Designing a study to encourage exercise adherence and long-term weight control in sedentary overweight women was a major goal of this study. Exercise, regardless of its benefits, is not going to be an effective intervention unless it becomes habitual. It was shown that the benefits of exercise such as decreased body fat, increased fitness level, and weight maintenance are possible with exercise of a moderate intensity. At this intensity, however, exercise-induced changes in FFM and REE do not occur. Exercise beyond a moderate intensity may be required to see changes in FFM and REE but may be inappropriate to

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encourage adherence in a sedentary overweight population. The preferences for walking as a mode of exercise were also documented. Walking for exercise should be encouraged because it is simple, inexpensive, convenient, it poses minimal risk of injury, and it has the potential for social interaction.

In terms of weight management, it was shown that exercise prevents seasonal weight gain that might otherwise occur in the absence of exercise. As shown in the control group, a weight gain of approximately 6 lbs may occur during the fall and winter.

Finally, as found in previous studies, it was shown that factors such as group homogeneity, social networking, a leader with a health-related background, time limitation of the program, and commitment to a goal influenced continuation and completion of the exercise program. Behaviour strategies such as self-monitoring/record keeping, goal setting, and time management were also seen by participants as important for adherence. The strength of personal incentives as a motivator to exercise is unknown. In encouraging exercise in individuals with little experience with exercise, the primary challenge for health promoters may be to convince these individuals that exercise can be enjoyable.

In conclusion, there remain many unanswered questions concerning exercise and weight management. For example, do physically active

individuals have higher REEs than sedentary individuals as a result of exercise? What is the optimum intensity and/or duration to favour changes in FFM and REE in this population?

5.3 SPECIFIC RECOMMENDATIONS

i) Weather conditions in October and November in Vancouver, B.C. are not ideal for an outdoor exercise program. It is recommended that future studies of this kind should not take place during the fall or else researchers should be prepared to make alternate plans during inclement weather.

ii) Location of the exercise site is also important. It is recommended that the site be a central location where most participants work or study. Accessible and free parking must be considered. This was often a problem and caused many late arrivals to class.

iii) The use of mail as a means of collecting diet records and questionnaires should be avoided. In some cases, it took participants months to return information. A few packages were also lost through Canada Post.

iv) As four of the women in the resistance group suggested, it is recommended that a social 'ice-breaker' be used at the beginning of the first few classes of any exercise program to make participants aware of each others' names.

v) Although factors such as group homogeneity and behaviour strategies such as record keeping and goal setting were found to influence exercise adherence, there was still quite a high dropout rate from all three groups in the study. How can this dropout rate be decreased? Would token reinforcement or incentives in the form of a program fee be effective? Is it possible to decrease or prevent this dropout rate? Further, what would motivate individuals such as those in the control group to exercise in the first place? Most of these individuals had no intention of ever exercising. Clearly, other factors regarding exercise motivation and adherence need to be examined.

vi) Arrangements should be made to follow-up these women over the next year. It is important to determine whether any lifestyle changes were maintained after completion of the program. A major focus of this research was to initiate an exercise program which participants could then continue on their own. If participants find themselves returning to their old habits, future exercise interventions may need to consider a long-term intervention.

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vii) It would also be important for future research in the area of exercise and weight management to assess the effects of exercise on certain psychological factors such as locus of control, self-esteem, and depression. Such research may provide additional insight into the motivation factor concerning exercise adherence.

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Appendix A

Consent Form for Experimental Group

CONSENT FORM

Metabolic Effects of Weight Cycling: Exercise Intervention Strategies

It is well known that weight loss programs result in limited success over the long term. Thus, people often fall into a pattern of repeated cycles of weight loss and regain. Regular exercise appears to be one of the best predictors of long term weight maintenance. Thus, the purpose of this study is to assess two types of exercise programs to determine which has more beneficial effects on basal metabolism, body composition and overall fitness.

Test procedures include:

- a) Completion of a questionnaire on dieting history and appetite.
- b) Measurement of resting metabolic rate by indirect calorimetry. Subjects must breathe into a mouthpiece and hose attached to a computerized machine which analyzes the breath sample. A noseclip must also be worn. This takes about 30 minutes.
- c) Measurement of body composition by bioelectric impedance analysis (BIA). BIA is rapid, painless, non-invasive means of determining body composition in which electrodes are attached to the wrists and ankles and a weak electric current is passed between them. Subjects are laying down during the procedure.
- d) Body composition will be measured by a second method using skinfold thickness. Skinfold thickness measurements are rapid and painless and will be completed at eight sites (biceps, triceps, subscapular, suprailiac, supraspinale, abdominal, thigh, medial calf) while the subject is standing. Also, six girth measurements (waist, hip, arm, forearm, thigh, calf) will be taken.
- e) Assessment of aerobic fitness by a 12 minute timed Cooper walk-run test. On a running track of known distance, subjects walk/run as far as they can in 12 minutes.
- f) Completion of a 3 day diet record by each subject which will be analyzed for nutrient intake.

Note: All tests (except the dieting history questionnaire) will be done pre and post exercise program intervention.

The exercise program itself will be co-ordinated by a Sport Medicine Physician and the activity will be increased gradually.

Subjects will be given a code number by which all data will be identified. All personal information will be confidential.

Subjects will be required to participate in the pre and post tests (approx. 4 hours each time) and exercise for 1 hour (four times per week) for 3 months.

If subjects have further questions concerning the study, the investigators listed below can be contacted.

Subjects may refuse to participate or may withdraw from the study at any time without jeopardy to further medical care.

Thus I, _____ hereby consent to participate in this study and acknowledge that I have received a copy of this consent form and of the study protocol.

Signature of Subject: _____

Signature of Witness: _____

Date: _____

If any questions, please call:

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Appendix B

Consent Form for Control Group

CONSENT FORM

Metabolic Effects of Weight Cycling

Test procedures include:

- a) Completion of a questionnaire on dieting history and appetite.
- b) Measurement of resting metabolic rate by indirect calorimetry. Subjects must breathe into a mouthpiece and hose attached to a computerized machine which analyzes the breath sample. A noseclip must also be worn. This takes about 30 minutes.
- c) Measurement of body composition by bioelectric impedance analysis (BIA). BIA is rapid, painless, non-invasive means of determining body composition in which electrodes are attached to the wrists and ankles and a weak electric current is passed between them. Subjects are laying down during the procedure.
- d) Body composition will be measured by a second method using skinfold thickness. Skinfold thickness measurements are rapid and painless and will be completed at eight sites (biceps, triceps, subscapular, suprailiac, supraspinale, abdominal, thigh, medial calf) while the subject is standing. Also, six girth measurements (waist, hip, arm, forearm, thigh, calf) will be taken.
- e) Completion of a 3 day diet record by each subject which will be analyzed for nutrient intake.

Subjects will be given a code number by which all data will be identified. All personal information will be confidential.

Subjects will be required to participate in the pre and post tests (approx. 1 hour each time).

If subjects have further questions concerning the study, the investigators listed below can be contacted.

Subjects may refuse to participate or may withdraw from the study at any time without jeopardy to further medical care.

Thus I, _____ hereby consent to participate in this study and acknowledge that I have received a copy of this consent form and of the study protocol.

Signature of Subject: _____

Signature of Witness: _____

Date: _____

If any questions, please call:

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Appendix C

Subject Information Sheet

Metabolic Consequences of Recurrent Dieting: Exercise Intervention Strategies

SUBJECT INFORMATION SHEET

Name _____ Age _____

Date of Birth: _____

Address _____

Home phone: _____ Hours available _____

Business phone: _____ Hours available _____

Briefly explain the last diet you were on: _____

How long were you on this diet? _____ How much weight
did you lose? _____

Do you participate in any form of exercise? _____ If YES,

please list the type of exercise and the amount of time you devote to

each activity per day and the number of times you engage in each

activity per week:

ACTIVITY	TIME per DAY	# of TIMES per WEEK
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Are you able to attend 2 test periods of approx. 4 hours per session? _____

Are you able to participate in 3 supervised and 1 unsupervised exercise periods per week for 3 months beginning September 03.1992?. _____

Do you have any chronic illnesses? _____ If yes please list: _____

Do you have Thyroid disease? _____

Do you have Diabetes? _____

Are you taking any medication that may affect study results? (ie. anti-depressants, lithium, beta blockers) _____

If yes, please list medications:

Menstruation may affect metabolic rate. Could you please document the

DATE of the BEGINNING of your last period: _____

THANK YOU

Appendix D

Weight Cycling Questionnaire

WEIGHT CYCLING QUESTIONNAIRE

Name _____

Date _____

DIETING HABITS

1a. Have you ever tried to lose weight by dieting, ie., restricting food intake to a level less than usual? (please circle the appropriate number)

1. No, never
2. Yes, once
3. Yes, more than once

2a. How often are you dieting to try to lose weight?

1. Never
2. Rarely
3. Sometimes
4. Often
5. Always

3a. Have you tried the following weight loss diet programs or methods to lose weight in the past five years?

YES NO

Weight Watchers	_____
Diet Center	_____
TOPS	_____
Nutrisystem	_____
Herbalife	_____
Formula Diets (specify)	_____
Diet books (specify)	_____
Hospital program	_____
Overeaters Anonymous	_____
Diuretics/emetics	_____
Registered Dietician/Nutritionist	_____
other (please specify)	_____

4a. How many times have you tried to lose weight in the past year?

1. 0
2. 1-2
3. 3-5
4. 6-9
5. 10 or more

5a. For what reason(s) have you dieted to lose weight? (please circle all that apply)

1. To look more attractive
2. Health reasons, with a Doctor's advice
3. Health reasons, without a Doctor's advice
4. A sport or athletic event, with coach's advice
5. A sport or athletic event, without a coach's advice
6. Other (please specify) _____

6a. When was the last time you started a diet to lose weight?

1. Within the last two weeks
2. Within the last month
3. Within the last six months
4. Within the last year
5. more than one year ago

7a. How much weight did you want to lose on your most recent diet? _____ lbs.

8a. How much weight did you lose on your most recent diet? _____ lbs.

9a. How long did you stay on your most recent diet? _____

10a. How old were you when you first dieted to lose weight? _____

11a. Are you a YO-YO dieter (ie. do you experience frequent weight losses and regains)?

1. Yes
2. No

PATTERNS OF WEIGHT LOSS AND WEIGHT GAIN

1b. What is the maximum amount of weight you have ever lost within one week, not due to illness or pregnancy? _____ lbs.

2b. What is your maximum weight gain within a week? _____ lbs.

3b. When you gain weight, where do you gain it?(please check all that apply)

- _____ around the waist, abdomen
- _____ hips, thighs and buttocks
- _____ all over
- _____ elsewhere (please specify)
- _____ not applicable- my weight gain is minimal

4b. When you lose weight, where do you lose it?(please check all that apply)

- _____ around the waist, abdomen
- _____ hips, thighs and buttocks
- _____ all over
- _____ elsewhere (please specify)
- _____ not applicable- my weight loss is minimal

5b. How many times in the past 5 years would you estimate you have lost the number of pounds shown below, excluding pregnancy/post-partum? (please write # of times)

Weight loss	Number of times
1-5 lbs	_____
6-10 lbs	_____
11-20 lbs	_____
21-30 lbs	_____
31-50 lbs	_____
51 + lbs	_____

6b. Describe your weight between the ages: (check where appropriate)

	6-10	11-13	14-17	18-25	+26
Extremely thin	_____	_____	_____	_____	_____
Very thin	_____	_____	_____	_____	_____
Somewhat thin	_____	_____	_____	_____	_____
Average	_____	_____	_____	_____	_____
Somewhat-overweight	_____	_____	_____	_____	_____
Very overweight	_____	_____	_____	_____	_____
Extremely-overweight	_____	_____	_____	_____	_____

7b. What has been your minimum weight as an adult (> 25 yrs old)? _____ lbs.

8b. What has been your maximum non-pregnant weight as an adult?
_____ lbs.

9b. Have you ever purged (used self-induced vomiting, laxatives, diuretics, emetics) to control your weight? If NO, go to question #16b.

1. Yes
2. No

10b. Have you ever vomited to control weight? If NO go to question #12b

11b. How often do you vomit to control weight?

1. less than once per month
2. 1-3 times per month
3. once per week
4. 2-6 times per week
5. daily
6. more than once per day

12b. Have you ever used laxatives to control weight? If NO go to question #14b.

13b. How often do you use laxatives to control weight?

1. less than once per month
2. 1-3 times per month
3. once per week
4. 2-6 times per week
5. daily
6. more than once per day

14b. Have you ever used diuretics to control weight? If NO go to question #16b

15b. How often do you use diuretics to control weight?

1. less than once per month
2. 1-3 times per month
3. once per week
4. 2-6 times per week
5. daily
6. more than once per day

16b. How satisfied are you with your current weight?
(please circle number)

1 2 3 4 5 6 7
Not Moderately Extremely
Satisfied Satisfied Satisfied

17b. How satisfied are you with your current body shape?

1 2 3 4 5 6 7
Not Moderately Extremely
Satisfied Satisfied Satisfied

18b. What would you consider to be your IDEAL weight? _____ lbs.

EXERCISE HISTORY

1c. Do you engage in any form of exercise? If so, please list the activity and the # of hours/week you participate in each activity:

ACTIVITY	# HOURS PER WEEK
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

Appendix E

Three-Factor Eating Questionnaire

EATING QUESTIONNAIRE

NAME: _____

NUMBER : _____

- | | | | |
|-----|---|---|---|
| 1. | When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. | T | F |
| 2. | I usually eat too much at social occasions, like parties and picnics. | T | F |
| 3. | I am usually so hungry that I eat more than three times a day. | T | F |
| 4. | When I have eaten my quota of calories, I am usually good about not eating anymore | T | F |
| 5. | Dieting is so hard for me because I just get too hungry. | T | F |
| 6. | I deliberately take small helpings as a means of controlling my weight | T | F |
| 7. | Sometimes things just taste so good that I keep on eating even when I am no longer hungry. | T | F |
| 8. | Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat | T | F |
| 9. | When I feel anxious, I find myself eating. | T | F |
| 10. | Life is too short to worry about dieting. | T | F |
| 11. | Since my weight goes up and down, I have gone on reducing diets more than once. | T | F |
| 12. | I often feel so hungry that I just have to eat something. | T | F |
| 13. | When I am with someone who is overeating, I usually overeat too. | T | F |
| 14. | I have a pretty good idea of the number of calories in common food. | T | F |
| 15. | Sometimes when I start eating, I just can't seem to stop. | T | F |
| 16. | It is not difficult for me to leave something on my plate. | T | F |
| 17. | At certain times of the day, I get hungry because I have gotten used to eating then. | T | F |
| 18. | While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. | T | F |
| 19. | Being with someone who is eating often makes me hungry enough to ^{eat} also. | T | F |
| 20. | When I feel blue, I often overeat. | T | F |
| 21. | I enjoy eating too much to spoil it by counting calories or watching my weight. | T | F |
| 22. | When I see a real delicacy, I often get so hungry that I have to eat right away. | T | F |
| 23. | I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. | T | F |

- | | | | |
|-----|--|---|---|
| 24. | I get so hungry that my stomach often seems like a bottomless pit. | T | F |
| 25. | My weight has hardly changed at all in the last ten years. | T | F |
| 26. | I am always hungry so it is hard for me to stop eating before I finish the food on my plate. | T | F |
| 27. | When I feel lonely, I console myself by eating. | T | F |
| 28. | I consciously hold back at meals in order not to gain weight. | T | F |
| 29. | I sometimes get very hungry in the evening or at night. | T | F |
| 30. | I eat anything I want, any time I want. | T | F |
| 31. | Without even thinking about it, I take a long time to eat. | T | F |
| 32. | I count calories as a conscious means of controlling my weight. | T | F |
| 33. | I do not eat some foods because they make me fat. | T | F |
| 34. | I am always hungry enough to eat at any time. | T | F |
| 35. | I pay a great deal of attention to changes in my figure. | T | F |
| 36. | While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. | T | F |

PART II

Directions: Please answer the following questions by circling the number above the response that is appropriate to you.

37. How often are you dieting in a conscious effort to control your weight?

1	2	3	4
rarely	sometimes	usually	always

38. Would a weight fluctuation of 5 lbs affect the way you live your life?

1	2	3	4
not at all	slightly	moderately	very much

39. How often do you feel hungry?
- | | | | |
|-------------------|-------------------------|---------------------|---------------|
| 1 | 2 | 3 | 4 |
| only at mealtimes | sometimes between meals | often between meals | almost always |
40. Do your feelings of guilt about overeating help you to control your food intake?
- | | | | |
|-------|--------|-------|--------|
| 1 | 2 | 3 | 4 |
| never | rarely | often | always |
41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?
- | | | | |
|------|--------------------|----------------------|----------------|
| 1 | 2 | 3 | 4 |
| easy | slightly difficult | moderately difficult | very difficult |
42. How conscious are you of what you are eating?
- | | | | |
|------------|----------|------------|-----------|
| 1 | 2 | 3 | 4 |
| not at all | slightly | moderately | extremely |
43. How frequently do you avoid 'stocking up' on tempting foods?
- | | | | |
|--------------|--------|---------|---------------|
| 1 | 2 | 3 | 4 |
| almost never | seldom | usually | almost always |
44. How likely are you to shop for low calorie foods?
- | | | | |
|----------|-------------------|-------------------|-------------|
| 1 | 2 | 3 | 4 |
| unlikely | slightly unlikely | moderately likely | very likely |
45. Do you eat sensibly in front of others and splurge alone?
- | | | | |
|-------|--------|-------|--------|
| 1 | 2 | 3 | 4 |
| never | rarely | often | always |
46. How likely are to consciously eat slowly in order to cut down on how much you eat?
- | | | | |
|----------|-----------------|-------------------|-------------|
| 1 | 2 | 3 | 4 |
| unlikely | slightly likely | moderately likely | very likely |

47. How frequently do you skip dessert because you are no longer hungry?

1	2	3	4
almost never	seldom	at least once a week	almost every day

48. How likely are you to consciously eat less than you want?

1	2	3	4
unlikely	slightly likely	moderately likely	very likely

49. Do you go on eating binges though you are not hungry?

1	2	3	4
never	rarely	sometimes	at least once a week

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never 'giving in'), what number would you give yourself?

0
eat whatever you want, whenever you want it

1
usually eat whatever you want, wherever you want it

2
often eat whatever you want, whenever you want it

3
often limit food intake, rarely 'give in'

4
usually limit food intake, rarely 'give in'

5
constantly limiting food intake, never 'giving in'

51. To what extent does this statement describe your eating behavior? 'I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow.'

1	2	3	4
not like me	little like me	pretty good description of me	describes me perfectly

Appendix F

Three-Day Diet Record

The following information is used to assess the nutritional adequacy of your diet. Please answer all questions and record food intake as accurately as possible.

I. PERSONAL DATA

Sex: Female ___ Male ___
 Birthdate: _____
 Age: _____ Years
 Height: _____ cm OR _____ ft _____ inches
 Weight: _____ kg OR _____ lbs.
 Desired Weight (if applicable):
 _____ kg OR _____ lbs.

III. FOOD RECORD

List everything you eat or drink for 3 days (ideally 2 weekdays + 1 weekend day). Record immediately after each meal and snack to ensure accuracy. Be sure to include:

- ALL FOOD AND DRINKS**, including all snacks, soft drinks, wine, alcohol, cream and sugar in coffee and tea, butter or sauces on vegetables, jams, relishes, candies, butter, margarine or mayonnaise in sandwiches, salad dressings, etc. Combination foods must be broken down. (eg. omelette = 2 eggs + 1 oz. cheddar cheese + 1/2 Tbsp. vegetable oil in pan).
 - THE AMOUNT OF FOOD** that was consumed. This is extremely important to ensure that an accurate analysis can be performed. Be as specific as possible. Use the attached diagrams and the following instructions to record precise portion sizes.
 - Use **VOLUME** measures (cups, Tbsp, tsp or ml) for cereals, rice, pasta, vegetables, cut fruit, beverages, peanut butter, mayonnaise, butter, margarine, sauces, gravies, soups, honey, sugar, jams, jellies, etc.
 - Use **WEIGHTS** (ounces or grams) for meat, fish, poultry, cheese. Use the attached diagrams, read food labels for weight or ask the cook.
 - Use **SIZE** for fruits, vegetables, muffins, buns, crackers, cakes, pies, cookies, desserts, etc. Give dimensions (eg. 1 cookie, 2" diameter) or specify small, medium or large based on the attached models. Some combination dishes (eg. pizza, lasagna) may be described by dimensions or by part of a whole piece (eg. 1/4 of 12" pizza and remember to list the toppings!).
 - THE TYPE OF FOOD & BRAND NAMES**, if applicable. Be specific.
 eg. whole wheat bread 2 slices mozzarella cheese 30 grams
 2% milk 1 cup Ritz crackers 4 crackers
 - THE TIME OF DAY** these foods and drinks were consumed.
- ** THE MORE ACCURATELY YOU REPORT, THE MORE MEANINGFUL IS THE ANALYSIS. **

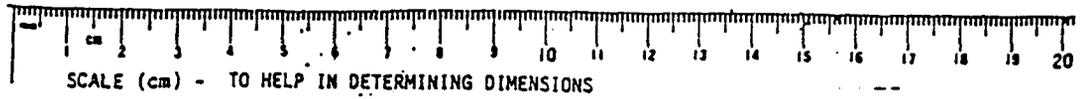
II. DIET INFORMATION

- Describe any special diet you follow. (eg. diabetic diet, weight loss/weight gain diets, pregnant, nursing, etc.)

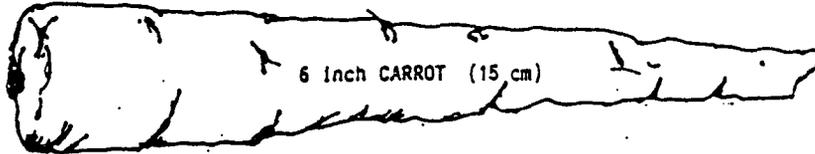
- Describe any nutrient supplements you take. (eg. vitamin/mineral supplements) Include brand names. _____
 Doseage per day: _____
- Describe any medications you take.

SAMPLE DAY			DAY 1		
Was this a fairly typical day? Y N			Was this a fairly typical day? Y N		
If not, please give reason: _____			If not, please give reason: _____		
TIME	FOODS	AMOUNT	TIME	FOODS	AMOUNT
7:00	Cheerios Milk, 2% Orange juice, canned	1 cup 1/2 cup 280 ml			
noon	Ham Sandwich: Cooked ham Whole wheat bread Margarine Tomato Apple Bran muffin Milk, 2%	2 oz. 2 slices 1 tsp. 1/2 med. 1 med. 1 med. 1 carton (250 ml)			
6:00	Roast beef Gravy Carrots, cooked Salad: Romaine lettuce Tomato Radishes Mushrooms Regular Italian Dressing Watermelon Coffee Creamer	3 oz. 2 Tbsp. 1/2 cup 1 cup 1/2 med. 2 med. 1/4 cup 2 Tbsp. 1 cup 1 cup 1 Tbsp.			

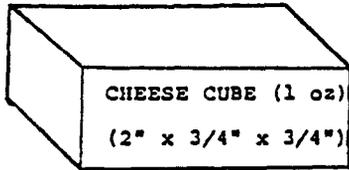
* Please print clearly.
 Add extra sheets if necessary.



II. SIZE



III. WEIGHTS

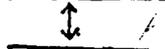


4 ounces of raw meat = 3 ounces of cooked meat

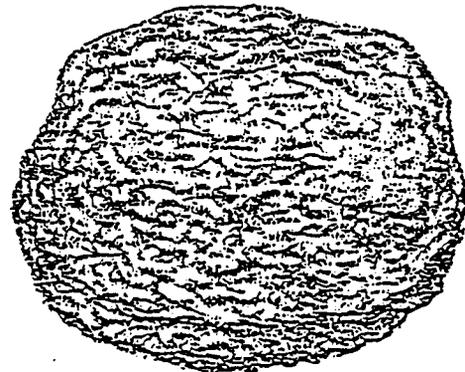
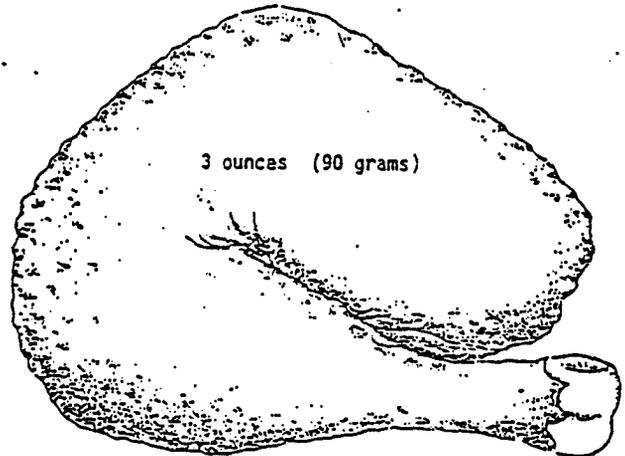
Half a chicken breast and wing or one leg and thigh cooked is equal to about 3 ounces of meat.

1 ounce = 30 grams

One hamburger pattie this thick is equal to 3 ounces.



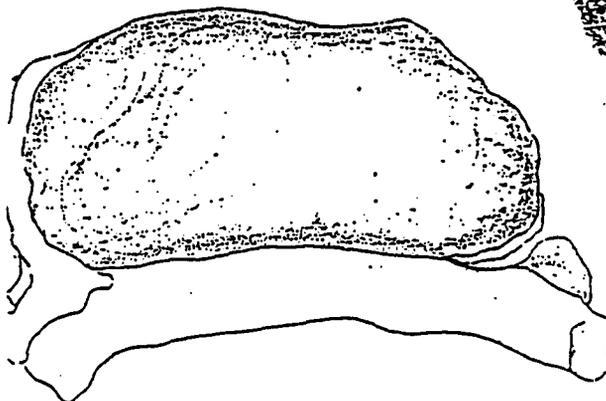
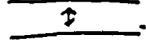
One hamburger pattie this thick is equal to 2 ounces.



A pork chop this thick is equal to 3 ounces.



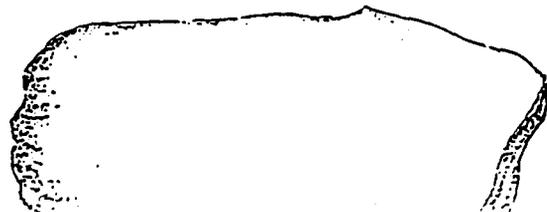
A pork chop this thick is equal to 2 ounces.



One slice of meat this thick is equal to 3 ounces.



Two slices of meat this thick are equal to 3 ounces.



Appendix G

Physical Activity Readiness Questionnaire (PAR-Q)

Appendix B

Physical Activity Readiness Questionnaire (PAR-Q)*

NAME OF PARTICIPANT _____

DATE _____

PAR Q & YOU

PAR-Q is designed to help you help yourself. Many health benefits are associated with regular exercise, and the completion of PAR-Q is a sensible first step to take if you are planning to increase the amount of physical activity in your life.

For most people physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable for them.

Common sense is your best guide in answering these few questions. Please read them carefully and check (✓) the YES or NO opposite the question if it applies to you.

YES NO

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Has your doctor ever said you have heart trouble? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Do you frequently have pains in your heart and chest? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. Do you often feel faint or have spells of severe dizziness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Has a doctor ever said your blood pressure was too high? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Has your doctor ever told you that you have a bone or joint problem such as arthritis that has been aggravated by exercise, or might be made worse with exercise? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Are you over age 65 and not accustomed to vigorous exercise? |

If
You
Answered

YES to one or more questions

If you have not recently done so, consult with your personal physician by telephone or in person **BEFORE** increasing your physical activity and/or taking a fitness appraisal. Tell your physician what questions you answered YES to on PAR-Q or present your PAR-Q copy.

programs

After medical evaluation, seek advice from your physician as to your suitability for:

- unrestricted physical activity starting off easily and progressing gradually,
- restricted or supervised activity to meet your specific needs, at least on an initial basis. Check in your community for special programs or services

NO to all questions

If you answered PAR-Q accurately, you have reasonable assurance of your present suitability for:

- A **GRADUATED EXERCISE PROGRAM** – a gradual increase in proper exercise promotes good fitness development while minimizing or eliminating discomfort;
- A **FITNESS APPRAISAL** – the Canadian Standardized Test of Fitness (CSTF).

postpone

If you have a temporary minor illness, such as a common cold.

Developed by the British Columbia Ministry of Health. Conceptualized and critiqued by the Multidisciplinary Advisory Board on Exercise (MABE). Translation, reproduction and use in its entirety is encouraged. Modifications by written permission only. Not to be used for commercial advertising in order to solicit business from the public.

Reference: PAR-Q Validation Report. British Columbia Ministry of Health, 1978.

Produced by the British Columbia Ministry of Health and the Department of National Health & Welfare.

Appendix H
Physician's Signature Form

Appendix I

'Walking' Program Description

CONGRATULATIONS!!

YOU HAVE SELECTED THE EXERCISE GROUP WHICH WILL FOCUS ON:

An Aerobic Walking Program

(ie."The Walking Group")

This will involve a one hour supervised walking session which will improve your overall fitness. Cardiovascular fitness should improve, but also muscular strength, particularly in the leg muscles should also increase somewhat over time. There will be a warm-up and cool-down at the beginning and end of each session. You will be asked to monitor your own heart rate periodically throughout the daily walks to aim for a target heart rate zone which is safe for you.

The theory behind this type of program is that you are burning calories, not only during the activity, but also for an extended period after the walking is over. If the program is continued on a regular basis, eventually you will get stronger and more fit and be able to expend more energy even within the one hour period. In theory, this should help with weight control, because you will be expending more energy on a daily basis.

The Next Step:

Please report to the track behind the Sports Medicine Clinic (where you did the Cooper Test) on Tues Sept.8, 1992 at 5:00 P.M.

*wear exercise clothes and good running shoes.

*wear appropriate outer clothing. WE WILL GO WALKING RAIN OR SHINE!! IT IS VANCOUVER AFTER ALL...

*at first the session will be just around the track.

Everyone can go their own pace and keep track of the distance covered. Small groups of similarly-paced walkers will probably result.

*later, if you prefer, we can go on walks around campus, however it will be dark by that time in late fall.

*washrooms and changing facilities are available in Osborne Gym adjacent to the sports fields. You are encouraged to bring your own water bottle.

And as they say on the NIKE commercials: "JUST DO IT!"

Appendix J

'Toning' Program Description

CONGRATULATIONS!!

YOU HAVE SELECTED THE EXERCISE GROUP WHICH WILL FOCUS ON:

Overall Body Toning Using Light Weights

(ie."The Toning Group")

This will involve a one hour class which will strengthen and tone all the major muscle groups. There will be a warm-up and some movement activities between the toning segments and a cool-down. There will be no jumping involved and no sustained aerobic activity.

The theory behind this type of class is that you are strengthening your muscles and gradually, your body composition will change such that you have more lean tissue compared to fat, essentially changing the lean to fat ratio. Lean tissue is more metabolically active than fat and therefore over the long-term you will burn more calories, even at rest. In theory, this should help with weight control, because you will be expending more energy on a daily basis.

The Next Step:

Please report to Rm 30: Family and Nutritional Sciences Building on Tues Sept.8, 1992 at 5:00 P.M.

- *wear exercise clothes and runners (preferably white-soled).
- *bring a towel and a mat or foamy if possible.
- *washrooms and a water fountain are available.

And as they say on the NIKE commercials: "JUST DO IT!"

Appendix K

Test Results Mailed out to Experimental Group

Name _____

Age _____

	PRE-EXERCISE	POST-EXERCISE
Date	_____	_____
Height (cm)	_____	_____
Weight (kg)	_____	_____
BMI	_____	_____
Sum of 4SF	_____	_____
Sum of 8SF	_____	_____
Waist/Hip	_____	_____
% Fat	_____	_____
REE	_____	_____

*1 kg = 2.2 lbs
*2.5cm = 1 inch

Appendix L

Test Results Mailed out to Control Group

Name _____

Age _____

SUMMER

WINTER

Date	_____	_____
Height (cm)	_____	_____
Weight (kg)	_____	_____
BMI	_____	_____
Sum of 4SF	_____	_____
Sum of 8SF	_____	_____
Waist/Hip	_____	_____
% Fat	_____	_____
REE	_____	_____

*1 kg = 2.2 lbs
*2.5cm = 1 inch

Appendix M

Explanation of the Measurements (Sent with Appendices K and L)

MEASUREMENTS

Date:

Date of first visit.

BMI:

Body Mass Index = $\text{weight}/\text{height}^2$. For women, a BMI of 20 to 25 is considered a "healthy" weight range. Greater than 27 may increase health risk.

Sum of 4SF:

Sum of triceps, iliac crest, abdominal, and thigh skinfolds in millimetres.

Sum of 8SF:

Sum of biceps, triceps, subscapular, supraspinale, iliac crest, abdominal, thigh, and medial calf skinfolds in millimetres.

Waist/Hip:

Waist circumference divided by hip circumference. For women, less than .8 is considered desirable.

% Fat:

Derived from equation using the sum of 4SF, hip circumference, and age.

REE:

Number of calories expended per day in a resting state (ie. if one were to lie in bed all day).

Appendix N

Interim Diet Assessment

WEEK 6 (October 15th)

NAME: _____

We assessed your diet at the beginning of the study.
Do you feel that your dietary intake is about the same as it was then?

Yes _____ No _____

If "No", please explain what has changed since your first diet record.

Appendix O

Information to Record for the Logbook

INFORMATION FOR THE LOGBOOK

Your logbook will be like a diary for the three months of the exercise program. At the end of the program, you will be asked to hand it in.

There are roughly 100 pages in the book. Allocate one page for each day. If you wish, you can transfer the information from your baseline data (ie. height, weight, REE, etc.) to the front page of the book.

Information to record:

- 1) Any exercise that you do (both in-class exercise and the extra day that you exercise on your own). Remember, the exercise that you do on your own must follow the protocol of the class as closely as possible.
- 2) Your heartrates during the exercise. You will be given a chance to monitor your heartrate during each class.
- 3) The dates of your period and any unusual changes in your cycle.
- 4) Any unusual changes in your eating habits. Although we are not asking you to do anything about your diet, we are still interested in monitoring it.
- 5) Anything else you think may be important.

Appendix P

Exercise Adherence Questionnaire

EXERCISE ADHERENCE QUESTIONNAIRE

1) In your opinion, what factors influenced your continued participation and completion of the program? (eg. scheduled time, leadership, weather, type of exercise)

2) What factors could be improved?

3) Will you continue exercising in the same manner?

Yes

No

If no, what will be modified?

** It is possible that a follow-up will be conducted so we may get in touch with you in 6 to 10 months. Again, thank you very much for participating. **