PHYSICAL FITNESS, HEALTH, AND CARDIOVASCULAR RECOVERY FROM PSYCHOLOGICAL AND PHYSIOLOGICAL STRESS IN WOMEN

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Abstract

The present study examined the relationship of fitness and exercise to psychological state, health behaviours, and cardiovascular recovery from stress in a sample of 79 females aged 17 - 36 years. The study was conducted during two sessions. Fitness was appraised with the Canadian Standardized Test of Fitness (1986), modified to include a prediction of aerobic power (MVO2) from a sub-maximal workload on a bicycle ergometer. Cardiovascular recovery from both a mental and a physical stressor was measured. Questionnaires which assessed physical activity, health behaviours, life stress, mood, quality of life, and perceived exertion during the stressors were given. Few correlations between fitness and exercise behaviours, and health and psychological measures were found. Fitness (MVO2) was significantly correlated with faster systolic blood pressure recovery following the mental and physical stressors. However, MVO2 was not related to heart rate recovery; nor were the other fitness and exercise variables clearly related to cardiovascular recovery. The findings suggest caution in concluding that aerobic fitness yields or mediates clear psychological or stress-related benefits.

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PHYSICAL FITNESS, HEALTH, AND CARDIOVASCULAR RECOVERY FROM PSYCHOLOGICAL AND PHYSIOLOGICAL STRESS IN WOMEN

Introduction

Considerable interest in recent years has focused on the benefits of aerobic fitness for improved stress management. One paradigm for assessing the ability to cope with stress has been the examination of cardiovascular reactivity to stressful laboratory situations. The underlying rationale is that excessive and prolonged physiological activation of the stress response is undesirable as it may lead to future health problems (Long, 1991). Some researchers have proposed that the physiological adaptation, such as efficient cardiovascular functioning, associated with regular aerobic exercise (Nadel, 1985) may also have a positive influence on physiological reactivity to stress (Blumenthal et al., 1990; Hollander & Seraganian, 1984; Keller & Seraganian, 1984; Sachs & Buffone, 1984). Thus, if aerobically fit individuals experience more efficient recovery from stress than nonfit individuals, the fit persons may be more able to maintain a high standard of health and well-being.

Fitness

A variety of approaches have been used in fitness research which focus on either aerobic fitness, habitual physical exercise, training (van Doornen, de Geus, & Orlebeke, 1988), or physical activity. Fitness has been described as having the strength and stamina to accomplish daily tasks without unwarranted fatigue, and possessing ample energy to enjoy leisure time activities and to respond in unforseen emergencies (President's Council on Physical Fitness and Sports: Physical Fitness Research Digest, 1971). Physical activity is any bodily movement produced by skeletal muscles which results in the expenditure of energy (Caspersen, Christenson, & Pollard, 1986). Exercise has been defined as a subset of physical activity, which is structured, repetitive, and has the objective of improving or maintaining physical fitness (Caspersen et al., 1986). Training is the process of being involved with such exercise. Exercise does not necessarily lead to a training effect of improved aerobic fitness unless it is of sufficient intensity and duration (van Doornen et al., 1988).

Fitness and exercise are operationalized through a number of physical measurements and self-report instruments (Blair, 1984). The most widely used index

of fitness is maximal oxygen uptake (MVO2), a measure of an individual's aerobic power (Astrand & Rodahl, 1986; van Doornen et al., 1988; Williams & Eston, 1989). The exercise protocol in which MVO2 is assessed, requires the subject to exercise to exhaustion while breathing through a mouthpiece which shunts the expired air into a "gasometer". Ventilations, and oxygen and carbon dioxide concentrations are directly determined. From these measures, carbon dioxide production and the volume of oxygen consumption (VO2) can then be determined (de Geus, van Doornen, de Visser, & Orlebeke, 1990).

It is also possible to *estimate*, or *predict* one's maximum oxygen consumption from an exercise test which does not measure the actual oxygen uptake, and which requires less physical exertion (predicted MVO2; Astrand & Rhyming, 1954). Predicted MVO2 is based upon the subject's heart rate (HR) response to exercising against progressively increased resistance (e.g., on a bicycle ergometer), with the target level of resistance (power level) lower than that of the maximal test mentioned above. The HR attained is entered into a nomogram (Astrand & Rhyming, 1954) to estimate MVO2. This procedure allows for a study sample with a greater range of fitness, as more sedentary individuals may be less

willing to volunteer for an experiment which involves exercising to the point of physical exhaustion. Validity coefficients between the Astrand predicted values and the directly measured maximal oxygen consumption values range from .34 to .96 (de Vries, 1986; Kasch, 1984; Olha, Thompson, Skoryna, & Klissouras, 1980).

Aerobic fitness, although partly determined from training, is thirty percent genetically determined (Bouchard et al., 1986; de Geus et al., 1990; van Doornen et al., 1988). This latter idea has lead some investigators to be more interested in studying the benefits of exercise, and other dimensions of fitness, rather than aerobic fitness per se (e.g., Hughes, 1984). Other dimensions of fitness which have been investigated include muscular strength, muscular endurance, body composition, and flexibility (Canadian Standardized Test of Fitness; CSTF, 1986), and self-reports of perceived fitness level (Washburn, Adams, & Haile, 1987). On the other hand, exercise has also been operationalized in a number of ways. Exercise has been measured through objective indices of energy expenditure during exercise, employing observational techniques, diaries, and mechanical or electrical movement counters worn by the

subject (McGowan, Bulik, Epstein, Kupfer, & Robertson, 1984; Montoye & Taylor, 1984); and through self-report assessments of energy expenditure (Kohl, Blair, Paffenbarger, Macera, & Kronenfeld, 1988; Montoye & Taylor, 1984; Taylor et al., 1978). Exercise has also been assessed through caloric intake information (Buskirk, Harris, Mendez, & Skinner, 1971; Montoye & Taylor, 1984; Slattery, Jacobs, & Nichaman, 1989), and reported frequency and type of exercise engaged in (Kohl et al., 1988). As well, there are a number of self-report instruments for assessing habitual physical activity during sport, leisure time, and at work; most of which are based on energy expenditure (Baecke, Burema, & Frijters, 1982; Hopkins & Walker, 1988; Klesges et al., 1990; Sallis et al., 1985; Washburn & Montoye, 1986).

Benefits of Fitness

There is currently a widely held belief that fitness and exercise are associated with psychological benefits and improved psychological well-being (e.g., Folkins & Sime, 1981; Morgan & Goldston, 1987). This belief stems largely from self-reports of the exercise participants themselves (Sime, 1984). At present, the beneficial effects of fitness are explained on several

theoretical bases, including biochemical, physiological, psychoanalytic, neurophysiological, consciousness alteration, diversion, and psychological (Lawrence, 1983).

Well-being

It has been reported that increases in fitness level are accompanied by improved psychological well-being (e.g., Folkins & Sime, 1981). Well-being is a concept which embodies the dimensions of happiness, life satisfaction, positive affect (Diener, 1984), as well as health awareness, self-responsibility, and stress management (Townes, 1984). A number of findings have reported positive correlations between exercise and/or fitness and well-being (King, Taylor, Haskell, & DeBusk, 1989; Norris, Carroll, & Cochrane, 1990; Ross & Hayes, 1988). However, Rodin and Plante (1989) argue that although there appears to be an improvement of mood and well-being immediately following exercise, the evidence for long-term cumulative effects of exercise is not as compelling. For example, Berger and Owen (1988) found a reduction in tension and confusion immediately after swimming, but only on the first day of testing. As well, other researchers have even found reductions in one's sense of well-being in athletes involved in an

intense training program (Morgan, Costill, Flynn, Raglin, & O'Connor, 1988).

Affect

Some research has shown that exercise and/or an increase in fitness level has led to improved mood in the form of decreased state anxiety (Bahrke & Morgan, 1978; Boutcher & Landers, 1988; Morgan, 1985) trait anxiety (Czajkowski et al., 1990; Folkins, Lynch, & Gardner, 1972; Morgan, 1985; Ross & Hayes, 1988; Sonstroem & Morgan, 1989; Weinberg, Jackson, & Kolodny, 1988), depression (Folkins et al., 1972; Morgan, 1985; Ross & Hayes, 1988; Roth & Holmes, 1987; Sonstroem & Morgan, 1989; Weinberg et al., 1988), as well as reductions in tension, confusion, fatigue, and anger (Weinberg et al., 1988). Exercise has also been associated with happiness (Carter, 1977), optimism (Rodin & Plante, 1989) and vigour (Weinberg et al., 1988). However, other researchers have failed to find any significant changes in affect with the participation in exercise or an increase in fitness level. Failures to note any relationship of fitness or exercise with general mood (Agnew & Levin, 1987; Lennox, Bedell, & Stone, 1990), state anxiety (Sinyor, Golden, Steinert, & Seraganian, 1986), and depressed mood (Hughes, 1984)

have been observed.

Interestingly, some researchers have found benefits at some, but not other levels of exercise. This raises the issue of whether the assumed benefits of exercise are monotonically related to fitness level. There is no established dose-response curves which identify whether psychological benefits continue to increase with ever higher levels of exercise, or of fitness (Gavin, 1988; Haskell, 1987; King et al., 1989). It has been suggested that psychological benefits are maximally obtained from moderate but not extreme levels of exercise (King et al., 1989; Moses, Steptoe, Mathews, & Edwards, 1989). For example some studies (Moses et al., 1989; Steptoe & Cox, 1988) point to high-intensity exercise leading to an increase in tension, anxiety and fatigue; while positive mood changes (vigour and exhilaration) follow low or moderate intensity exercise only. Related to this notion, intense training was found to increase negative affect in elite athletes (Crossman & Jamieson, 1985; Morgan et al., 1988).

Researchers have argued that any improvements in mood depend, in part, on characteristics of the individual before fitness training. Some suggest that improvement in mood depends on the participant's initial

mood (Morgan, Roberts, Brand, & Feinerman, 1970; Sime, 1984; Simons & Birkimer, 1988). Others have argued that improvements depend on the individual's previous physical activity level (Kowal, Horstman, & Vaughan, 1979), but again, not everyone has found this effect (Gauvin, 1988).

Quality of Life

Morris and Husman (1978) report an improvement in life quality with the participation in exercise, but others have not found the same effect (Sinyor et al., 1986). When comparisons have been made between those who exercise and those who do not, researchers have not found any differences of quality of life and life stress (Gauvin, 1988; Spreitzer & Snyder, 1989).

Self-Perception

Positive correlations have been reported between exercise or fitness and self-esteem or self-concept (Brazell-Roberts & Thomas, 1989; Folkins et al., 1972; Folkins & Sime, 1981; Hanson & Nedde, 1974; Hughes, 1984; Kowal et al., 1979; Morgan, 1985; Rodin & Plante, 1989; Sinyor et al., 1986; Sonstroem & Morgan, 1989). However, in a study which compared women participating in a number of activity training groups to a control group, no differences in self-esteem were found (Ford,

Puckett, Blessing, & Tucker, 1989).

Studies have shown that the main psychological benefits of exercise relate directly to the physical benefits observed with exercise participation. These include an increase in perceived fitness level (King et al., 1989), improved subjective physical health (Agnew & Levin, 1987; Kowal et al., 1979; Ross & Hayes, 1988), and an increase with one's satisfaction with physical appearance (King et al., 1989; Kowal et al., 1979). However, in a review, Hughes (1984) did not find support that exercise improves body image.

Summary

While many of the above studies have found psychological benefits to be related to exercise or fitness, other studies have failed to detect such benefits. Moreover, even when the reported correlations are significant, they are often not of a large magnitude (e.g., Ross & Hayes, 1988). Research evidence for beneficial psychological effects from exercise participation is modest (Gavin, 1988).

Physiological Stress Reactivity

Several studies have reported that aerobically fit individuals exhibit smaller cardiovascular *responses* to stress than do unfit individuals (Holmes & Roth, 1985;

Holmes & Roth, 1988; Light, Obrist, James, & Strogatz, 1987; van Doornen & de Geus, 1989). These studies suggest a benefit of fitness due to the reduction in sympathetic reactivity. However, some other studies have found no effect of fitness on cardiovascular responding (Jamieson & La Voie, 1987; Sinyor et al., 1986), and some have reported larger responses for the fit subjects (Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983). At the present time the importance of fitness in determining the cardiovascular response to stress remains uncertain.

A problem in the study of laboratory stressors is the determination of what is in fact stressful. It has been established that the degree to which one appraises an event as threatening is a major determinant of how stressful the event will be, and consequently, how large a physiological response will be produced by the event (Lazarus & Folkman, 1984). Because of the importance of psychological factors in determining the stress response (individual differences in the perception of the stressor), one cannot assume that the same event is equally stressful for all subjects. The finding that fit subjects show smaller physiological responses to a stressor may simply indicate that fit subjects are less

"bothered by" these particular laboratory situations. Such an explanation may or may not have implications for how fit individuals deal with real life stressors.

On the other hand, a number of authors have pointed out that the *magnitude of the physiological response* to a stressor may not be as potentially pathological as a poor *rate of recovery* from the stress-induced activation (e.g., Dillbeck & Orme-Johnson, 1987). There is an assumption, or belief, that reduced physiological response to stress, or a faster physiological recovery, results in over-all less time spent experiencing stress at perhaps a lower level of stress (Crews & Landers, 1987). The stress response may have an influence on the rate of recovery, for example, a larger magnitude response will normally result in a slower recovery (a phenomenon called the "Law of Final Values"). However, by statistically partialling out the response magnitude, it becomes possible to obtain an index of recovery independent of the response magnitude. This residual recovery measure can therefore be used to identify individuals who exhibit a slower recovery, independent of their response to the stressor.

Recovery From Psychosocial Stress

It has been shown that aerobically fit individuals

exhibit faster HR recovery from a psychosocial stressor than unfit subjects (Cox, Evans, & Jamieson, 1979; Hollander & Seraganian, 1984; Sinyor et al., 1986). These findings identified faster recovery from mental stress as an additional benefit of aerobic fitness. Faster recovery from mental stress has been widely cited as an important justification for becoming more physically fit, since unnecessarily prolonged arousal may have detrimental effects on health through the extra "wear and tear" resulting from the sustained physiological activation (Dohrenwend & Dohrenwend, 1984; Folkins & Sime, 1981).

Other researchers have further investigated the relationship between aerobic fitness and recovery from psychosocial stress. Many of these studies failed to replicate the earlier finding, as no significant effects of aerobic fitness were found on cardiovascular responses to, or recovery from, the stressful situation (Jamieson & La Voie, 1987; Long, 1991; Zimmerman & Fulton, 1981). This has lead to a very mixed body of literature including both replications and failures to observe an effect of fitness on recovery from stress, to which no explanation has been established. It may be that the exercise type engaged in (i.e., aerobic vs.

anaerobic), or the psychological benefits of one's fitness level is more important in determining stress recovery. For example, Reid (1990) found that perceived fitness level was significantly correlated with faster HR recovery from both a physical stressor (hand grip) and a mental stressor (face to face quiz). At present there is a lack of consensus on the importance of aerobic fitness for faster recovery from stress (Long, 1991).

Mediators of Recovery

There also exists in the literature an issue of what may underlie, or mediate this persisting physiological arousal. The concept of "physiological toughness" (Dienstbier, 1989) may help to clarify the relationships between fitness (resting HR, aerobic fitness levels), healthy lifestyle behaviours, and the physiological benefits of the speed of recovery from stress. This concept of physiological toughness describes individuals who are better able to cope with stress, and who also exhibit better social adjustment and emotional stability. These individuals are characterized by "low arousal base rates with strong and responsive SNS-adrenal-medullary arousal (to challenge or threat) followed by quick decline..." (Dienstbier,

1989, p. 95). In contrast, a weak physiological pattern is characterized by pituitary-adrenal-cortical arousal, and is associated with defensiveness and ineffective coping. Therefore, according to this theory, physiologically tough individuals are hypothesized to show a lower resting HR, *greater reaction* to stress, and a *faster recovery* from stress than physiologically weak individuals.

According to Dienstbier (1989), physiological toughness is achieved through previous experience with physiological arousal, and he argues that aerobic exercise is one of the best ways to achieve this toughness. The implications are that if the person becomes "toughened" through fitness (or through the process of becoming fit) he or she will have less continued physiological arousal following each successive stressor.

Dienstbier's (1989) model focuses on fitness and fast recovery, two main variables of interest in the present investigation, and also suggests an index of "low arousal base rate". As well, his model suggests that physiological toughness, not fitness per se, is the process which underlies faster physiological recovery from stress. This provides direction to the sorts of

measures which might yield a clarification of the relationship of fitness level to faster recovery. These include: measures of low arousal base rate (resting HR, resting blood pressure; BP), measures associated with physiological toughness (participation in aerobic exercise, low perceived stress), and measures indicating a lack of physiological toughness (obesity, poor physical strength, excessive stress levels, and negative affect).

Recently, Boutcher (Boutcher, Nugent, Weltman, & Zinsser, 1989) reported that unfit subjects, characterized by a low MVO2 with low resting HR, responded to stressors in a manner identical to fit subjects (high MVO2, low resting HR), that is, these unfit subjects all displayed a lower response to stress and faster recovery than did unfit subjects with a higher resting HR. Thus his finding indicates that low resting HR, not aerobic power, was the determinant of faster recovery from stress.

Boutcher's (1989) work, like Dienstbier's (1989) points to low resting heart rate as a measure of potential importance which needs further exploration. This finding also raises the fundamental question of what aspects of fitness are responsible for conferring

benefits in the form of faster recovery from stress. While aerobic power (as measured by MVO2), is generally acknowledged to be the best index of cardiorespiratory fitness (Boreham, Paliczka, & Nichols, 1990), it does not necessarily follow that this measure "captures" the component of fitness most relevant for dealing with stress. That is, aerobic power may be the best measure of fitness for predicting endurance performance, but it may not be the best measure of "fitness" for predicting the rate of recovery from stress, nor for studying other benefits of exercise.

Women

There is currently a need to investigate the potential health benefits of fitness for females. Research on women's reactivity to stress is lacking in the literature despite sex differences in some physiological responses to stress (Stoney, Davis, & Matthews, 1987) and known differential health risks for women and men (Stoney, Langer, & Gelling, 1986). It has been observed that females in Canada have lower levels of cardiovascular fitness than do males (Canadian Fitness and Lifestyle Research Institute, 1983), and that females in Thunder Bay are less physically active than males (Kirk-Gardner & Crossman, 1989). It was

hoped that findings from this study would provide important motivation for increasing the activity levels in women's lifestyles.

In 1979, Cox et al. found that aerobically fit individuals displayed a faster HR recovery from a psychological stressor than unfit individuals. Their study included both male and female subjects, and while fitness was related to faster recovery in both genders, there was a significant interaction indicating that the relationship was stronger for females. In a follow-up study in 1987, Jamieson and La Voie failed to find an effect of fitness on cardiovascular recovery. This failure may have been due to their all-male sample, or the employment of a less severe stressor. It is possible that with the milder stressors used in studies of late, the effects will be more apparent in a female sample, which had initially shown a stronger effect (Cox et al., 1979).

The Present Study

The present study is correlational, designed to explore relationships between fitness, exercise, and psychological state, and cardiovascular recovery from stress in a female sample. It was anticipated that some of the uncertainties in the literature would be

clarified.

Information was gained on the physiological recovery from, and psychological reaction to two tasks: an anaerobic physical stressor (hand grip) and a psychological stressor (serial subtraction). The independent (predictor) variables were the fitness measures: aerobic capacity, strength, endurance, flexibility, perceived fitness level, and habitual exercise level. The dependent (criterion) variables were HR and BP recovery, perception of exertion during the stressors, and the measures of health behaviours and general psychological well-being.

Interrelationships among the following three sets of variables were explored:

1. Fitness was measured through self-report indices, anthropometric measures, physical tests, and predicted MVO2. Self-reported information included: one's perceived fitness level compared to others of the same age; the average number of times weekly that one exercises; and one's level of physical activity during work, sport, and leisure time. The anthropometric measures assessed body weight and fat distribution. Muscular strength, flexibility, and endurance were physically tested, while aerobic power (predicted MVO2)

was estimated from a submaximal workout on a bicycle ergometer.

2. Psychological well-being was assessed with self-report instruments measuring the perception of stress in one's life, one's quality of life, health behaviours, mood, and psychophysiological complaints.

3. Resting HR and BP, and two sets of measures of HR and BP recovery from stress were obtained; recovery from a psychological stressor and recovery from an anaerobic physical stressor. The rationale of using both stressors was to explore whether the faster HR recovery associated with fitness might be more evident for the physical stressor than for the mental stressor. While a variety of other physiological measures are available (e.g., van Doornen & de Geus, 1989), HR is the most reliable, recovers rapidly, and can be measured without discomfort to the subject.

Because of the continuing interest in the role of faster cardiovascular recovery, two questions are of particular interest:

1. Would faster recovery from stress be related to the psychological benefits of exercise? The answer to this question required an examination of whether faster recovery from stress was in fact associated with

positive psychological benefits.

2. Which of the four approaches for measuring fitness would be most strongly related to (predictive of) faster recovery from stress? Assuming faster recovery from stress is a benefit of aerobic fitness, it is important to clarify whether this benefit is simply a function of cardiovascular fitness, or whether it is more closely related to other more subjective indices such as perceived fitness level.

In addition to the specific questions of interest concerning fitness and recovery from physical and psychological stressors, it was hoped that this data base would permit an exploration of the role of a variety of health related behavioural variables which may underlie the effects of fitness.

Method

Subjects

Participants were 98 women recruited from the Thunder Bay community and university through public service announcements and advertisements. Volunteers were offered free fitness evaluations, and university psychology students received credit towards their course

mark. Exclusion criteria before any testing took place included having a history of clinical heart disease. The selection process did not exclude smokers or individuals using birth control pills, since to do so may have biased the sample. No participants were pregnant. Of the women tested, those who did not speak English as a first language and had difficulty understanding the questionnaires and instructions (n = 2), subjects taking medication affecting cardiovascular functioning or mood (n = 16), and subjects with a physical disability hindering the performance of some physical tasks (n = 1) were excluded from analysis. Therefore, data from 79 participants were analyzed. Ages ranged from 17 - 36 years (M = 26.4, SD = 5.8).

Apparatus

During the first session systolic (SBP) and diastolic blood pressure (DBP), in millimeters mercury, were recorded manually with the aid of a Trimline sphygmomanometer and a stethoscope. In the second session, SBP and DBP were recorded with a Marshall 85 battery-operated oscillometric sphygmomanometer. A stethoscope and a stopwatch were used to measure HR, in beats per minute, during the fitness test. In the

second session HR was recorded from two photoplethysmographic transducers attached to the first two fingers of the non-dominant hand. One transducer recorded HR on the polygraph paper of a Gilson electrocardiogram (ECG), while the other recorded HR (finger pulse and interbeat interval) into a computer program (Psylab, Contact Precision Instruments) being validated during this study. All analyses were made from the former HR recordings.

Predicted MVO2 was assessed from a test employing a Monark mechanically braked bicycle ergometer. A Taktell metronome was used to help the subject pedal at a steady pace. Muscular strength (hand grip) was measured with a Lafayette hand dynamometer; a flexometer (an instrument which measures how far forward the subject can bend and reach while sitting down) was employed to measure flexibility; and endurance required the use of a gym mat and a stopwatch.

Anthropometric measurements were made as outlined in the Canadian Standardized Test of Fitness (CSTF, 1986). This procedure makes use of a Healthometer Beam weigh scale for weight measurements, metric tape and a set square for height measurements, and John Bull fat calipers and anthropometric tape for skinfold and girth

measures.

The psychological stressor, an oral serial subtraction task, is a moderately stressful experience which has been previously used in psychophysiological studies (e.g., Ditto, France, & Miller, 1989; Long, 1991). The physical stressor involved the use of a Lafayette hand dynamometer.

Self-report Questionnaires

Initial screening of each subject's suitability for a fitness evaluation was carried out with the Physical Activity Readiness Questionnaire (PAR-Q; CSTF, 1986). The PAR-Q (Appendix A) has been designed to identify individuals deemed unsuitable for certain physical activities, and/or those who should receive medical advice concerning activities most appropriate for them.

A health behaviours questionnaire (Appendix B) was administered. On this questionnaire, requested information includes the subject's age, medication taken (including birth control pill), and current phase of menstrual cycle. As well, the questionnaire includes items concerning smoking and drinking (alcoholic beverages) practices, and the subject's satisfaction with, and conscientiousness in maintaining healthy behaviours. The subject is also asked to rate her

fitness level in comparison to other women her age (perceived fitness level has been shown to be a valid measure by Washburn et al., 1987).

A short questionnaire for the measurement of Habitual Physical Activity Level (HPAL; Baecke et al., 1982) was given. This 16-item instrument (Appendix C), includes three factors which have been distinguished as important descriptors of physical activity: physical activity at work (occupational physical activity); sport during leisure time; and physical activity during leisure time excluding sport. For items dealing with work and leisure time activities, the subject records the occurrence of usual activity on a 5-point scale ranging from "never" to "always". A sport activity index is calculated by the sum of the intensity of the activity multiplied by the time engaged, which is then multiplied by the proportion of the year participated in the sport. This allows separate activity indices to be calculated for work, sport, and leisure time based on energy expenditure. The HPAL, developed for use with the general population, has adequate test-retest reliability based on an interval of 3 months: work index (.88), sport index (.81), and leisure-time index (.74) (Baecke et al., 1982).

The Cohen - Hoberman Inventory of Physical Symptoms (CHIPS; Cohen & Hoberman, 1983) was employed as a measure of physical symptomatology. The CHIPS (Appendix D) is a listing of 39 common physical symptoms, traditionally viewed as psychosomatic. Items are rated for the degree to which the symptom bothered the subject during the past two weeks, on a 5-point scale from "not at all" to "extremely". The CHIPS has been found to have adequate reliability (Cohen & Hoberman, 1983).

The subject's perception of exertion experienced during the tasks was assessed with Borg's Rate of Perceived Exertion Scale (RPE-Scale; Borg, 1985; Borg & Ottoson, 1986). The RPE-Scale (Appendix E) is constructed to cover the total perceptual range from "no exertion at all" experienced during the task to "maximal exertion" experienced. Numbers from 6 to 20 correspond to a HR variation of 60 to 200 beats per minute. Correlations between HR and ratings range from .80 to .90 (Borg, 1985).

The degree to which nonspecific situations in one's life are appraised as stressful was measured by the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). The PSS (Appendix F) is an instrument of 14 items designed to tap the "degree to

which subjects found their lives unpredictable, uncontrollable, and overloading", as well as current levels of experienced stress (Cohen et al., 1983, p. 387). The items are quite general in nature in order to assess a global level of perceived stress. Each item is rated on the general frequency of feelings and thoughts related to stress during the last month. Items are rated on a 5-point scale from "never" to "very often". The PSS has been found to have substantial internal reliability (alpha = .84 to .86 for a variety of populations; Cohen et al., 1983). The test-retest correlation after 2 days was .85 in a college sample, and .55 for a smoking cessation group retested after 6 weeks (Cohen et al., 1983). Since the perceived stress levels are influenced by variable daily hassles, life events, and changes in coping resources, the test-retest correlations should be higher for intervals of a short duration than of a longer one.

The subject's quality of life was assessed by a self-report instrument, The Life Situation Survey (LSS; Chubon, 1987). The LSS (Appendix G) is made up of 20 items concerned with different aspects of the subject's present life situation, to which she agrees or disagrees on a 6-point rating scale. Test-retest reliability for

a 1-week interval is .91 based on data from graduate-level university students. However, the measure is situationally dependent, and retest reliability is expected to diminish over time (Chubon, 1987). Inter-item reliability coefficients (Cronbach's alpha), a more appropriate measure, range from .74 to .95 for diverse populations (Chubon, 1987). The LSS has been found to have substantial discriminant validity with sensitivity to health and non-health factors which affect perceived quality of life (Chubon, 1987).

Mood was assessed with the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) used frequently in studies concerning psychological benefits of fitness (e.g., Berger & Owen, 1988; Kowal et al., 1979; LeUnes, Hayward, & Daiss, 1988; Moses et al., 1989). The POMS (Appendix H) is an index of emotional levels more lasting than those produced by a short event, yet more transient than personality traits (McNair et al., 1971). The instrument is comprised of 65 adjectives factored into six dimensions of mood (tension, anger, depression, vigour, fatigue, and confusion). Respondents are asked to describe their feelings related to each adjective during the past week on a 5-point likert scale from "not at all" to "extremely". Test-retest reliability

coefficients range from .65 (vigorous) to .74 (depression).

Procedure

Interested individuals were initially contacted by telephone and screened for suitability for a fitness assessment with the PAR-Q. Volunteers were asked to wear loose, comfortable clothing to the first session. They were also requested to refrain from eating, drinking caffeine beverages, and smoking for 2 hours prior; and to avoid exercise and drinking alcoholic beverages for 6 hours prior to the sessions (CSTF, 1986). Subjects were individually tested during two sessions, which were separated by one week. Each session took approximately one hour.

The First Testing Session

The first session was carried out in the biomechanics laboratory at the School of Physical Education and Athletics. Participants were assured that all information collected would remain confidential, and signed two consent forms: one for the fitness evaluation (CSTF, 1986; Appendix I), the other for participating in the study (Appendix J).

After filling out the health behaviours questionnaire and the HPAL, resting HR, SBP, and DBP

measures were taken. BP was measured with a sphygmomanometer, the cuff placed on the artery of the upper non-dominant arm, just above the inside of the elbow. A manometer attached to the cuff indicated the pressure exerted on the arm. A stethoscope placed just beyond the cuff was used to detect the BP. HR, taken from the carotid artery of the neck, was assessed by timing the count of 30 beats, and calculating the beats per minute. HR and BP were taken before the fitness appraisal began, and every minute during the Astrand Bicycle Test starting at 1 minute, 30 seconds.

Anthropometric measures were then taken, following the CSTF procedure (1986; Appendix K). The subject's height was measured to the nearest 0.5 centimetres. Weight was recorded to the nearest 0.1 kilogram. Girth measurements (chest, abdomen, gluteal, and right thigh) were assessed with anthropometric tape, to the nearest 0.1 centimetres. Skinfold measurements (triceps, biceps, subscapular, iliac crest, medial calf) were taken from the right side of the body with calipers, and recorded to the nearest 0.2 millimetres. This procedure was completed twice, and the mean of the two readings was recorded.

The Astrand Bicycle Test (Astrand & Rhyming, 1954;

Appendix L) for predicting MVO2 was substituted for the aerobic fitness component of the CSTF. With this test oxygen uptake is not directly measured, but is an estimate based upon the steady state heart rate at a submaximal power level while cycling on a bicycle ergometer for 6 minutes (Astrand & Ryhming, 1954). The bike seat was adjusted for all subjects based upon accepted criteria (Powell, 1982). A pedal frequency rate of 50 revolutions per minute (metronome setting of 100 beats per minute) was used, based upon one foot pedalling the bottom stroke at each beat of the metronome. A subjective estimation of the appropriate workload was made for each subject. In general, the workload should elicit a target HR between 150 and 160 beats per minute for women subjects under 30 years of age, reducing the target HR by 1 beat per minute for each year over thirty.

After reaching a steady state HR on the bicycle ergometer, the subject was asked to cease pedaling while remaining seated on the bicycle for 10 minutes. During this recovery period BP and HR were measured at the first, fourth, and eighth minutes. These latter measures are an indication of the speed of physiological recovery from the aerobic exercise (this data is not

part of the present thesis). Perception of exertion experienced during the aerobic activity was assessed via Borg's RPE-Scale (1985).

The other fitness measures obtained via the CSTF procedure (1986; Appendix K) included muscular strength, flexibility, and muscular endurance. To measure muscular strength (grip strength), the participant was instructed to squeeze the dynamometer to exert maximum force, twice for each hand. The maximum score for each hand was combined and recorded to the nearest kilogram. Flexibility was assessed with the performance of two trials of the "trunk forward flexion", the distance the subject could reach by bending forward at the waist while sitting, making use of a flexometer. The maximum reading was recorded to the nearest 0.5 centimetres. Muscular endurance was assessed in the final test by the performance of consecutive push-ups completed without a time limit, and doing as many sit-ups as possible within one minute.

The participant did not receive any feedback at this time. She was told that she would receive her fitness evaluation following the second session.

The Second Testing Session

The second session was conducted in the laboratory

facilities of the Psychology Department, approximately one week following the fitness evaluation. Upon arrival at the laboratory, the subject was asked to spend a few minutes filling out the LSS, CHIPS, POMS, and the PSS self-report instruments. These were randomized for order across subjects so as to minimize any order effects. Following the questionnaires, the subject was taken into the human physiology laboratory and seated in a comfortable chair. She was told that the session involved her participation in a mental activity and a physical task. The subject was also told that HR would be monitored continuously. BP would be measured at the end of an initial 10 minute rest period, and during the first, fourth, and eighth minutes of the recovery period which followed each task. BP was not recorded during the two tasks, or in the first minute of recovery. BP was not measured as frequently as HR because the latter was the physiological measure of particular interest in the present study, for comparison with previous research (Cox et al., 1979; Jamieson & La Voie, 1987). It was felt that the measure of BP might interfere with the HR reactivity and recovery.

The blood pressure cuff was placed on the upper dominant arm. Two photoplethysmographic transducers

were attached to the index and middle fingers of the non-dominant hand: HR recorded by the computer program was measured from the transducer on the index finger, HR recorded on the ECG was from the transducer on the middle finger.

The participant was then instructed to close her eyes and relax for 10 minutes in order that baseline measures could be obtained. During this period resting HR was continuously recorded, and BP measures were recorded in intervals, with the baseline measures obtained from the final minute recorded.

After the rest period a serial subtraction task (the psychological stressor) was administered, which was a slight variation of the task used by Ditto et al. (1989). The subject received instructions to begin with the number 999 and to serially subtract the number 7, stating each answer aloud until told to stop by the experimenter. This task continued for 3 minutes. The experimenter corrected the subject's wrong answers, and at the midpoint asked the subject if she could "please go a little faster" in order to prevent the possibility of her "giving up". After the mental arithmetic period, the participant was asked to relax for another 10 minutes, during which time physiological recovery was

measured (HR continuously, BP during the first, fourth, and eighth minutes of recovery). After the first minute of recovery, the subject was asked to rate the perceived level of mental exertion experienced during the mental task using Borg's RPE-Scale (1985).

For the second part of the session, the subject was asked to squeeze the isometric hand dynamometer with her dominant hand, and to hold the needle at 30% of her maximum hand grip for 3 minutes. Following this physical stressor, the participant was asked to rest for a final 10 minutes during which time BP and HR recovery were measured. After 1 minute of recovery the subject was again asked to rate the perception of physical exertion experienced during the anaerobic task using the RPE-Scale (Borg, 1985).

Post-experimental briefing was then carried out. The subject was then thanked for her participation, and given her fitness profile (CSTF, 1979). Participants were offered the option of receiving a summary of the main findings from the study following the completion of analyses.

Data Computations

Three indicators for a comprehensive assessment of body weight, adiposity, and fat distribution were

calculated (CSTF, 1986) from the anthropometric measures. These indicators are the body mass index (BMI; the ratio of body weight divided by height squared in kilograms/squared metres), the sum of skinfolds (SOS; the sum of the five skinfold measurements in millimetres), and the waist to hip ratio (WHR; the ratio of abdomen girth divided by gluteal girth).

Astrand and Rhyming's (1954) nomogram was used in the prediction of MVO2 (Appendix L). Maximal oxygen consumption (predicted MVO2) expressed in millilitres per minute was divided by body weight in kilograms, yielding a weight-corrected maximal oxygen consumption (MVO2/kg).

All analyses were based on data from 79 cases. However, where data is missing (e.g., unscorable HR) analyses were based on reduced degrees of freedom.

Results

Preliminary Analyses: Fitness and Exercise Measures

Table 1 shows the mean and standard deviations of each index of fitness and exercise, and the intercorrelations between them. The high number of significant intercorrelations, in part, support the

Table 1

Intercorrelations of Fitness and Exercise Indices

	Fitness and Exercise Variables					
	MVO2	HR	SBP	DBP	BMI	WHR
MVO2						
HR	-.30**					
SBP	-.32**	.22				
DBP	-.38**	.03	.71**			
BMI	-.62**	.04	.47**	.47**		
WHR	-.31**	-.01	.18	.25**	.53**	
SOS	-.71**	.17	.51**	.46**	.90**	.46**
Grip	-.01	-.13	.22	.26*	.38**	.30**
Pushups	.41**	-.25*	-.08	.11	-.25*	-.34**
Situps	.50**	-.16	.27*	-.31**	-.39**	-.29*
Flexion	.19	-.09	-.01	-.10	-.20	-.13
Age	-.19	-.26*	.31**	.46**	.30**	.18
Selffit	.52**	-.31**	-.11	-.01	-.33**	-.22
Exerwk	.43**	-.28*	.01	.12	-.08	-.12
Pawork	.03	-.22	-.19	-.17	.03	-.08
Pasport	.39**	-.29**	.07	.18	.06	.10
Paleisure	.15	-.06	-.15	-.04	-.13	-.09
M	30.1	69.3	108.0	66.5	23.1	.7
SD	6.7	11.2	8.8	9.2	4.0	.04

Note. The higher the score, the greater the attribution.

Table 1 continued

	Fitness and Exercise Variables					
	SOS	Grip	Pushups	Situps	Flexion	Age
MVO2						
HR						
SBP						
DBP						
BMI						
WHR						
SOS						
Grip	.27*					
Pushups	-.41**	.09				
Situps	-.52**	-.05	.61**			
Flexion	-.22	-.08	.33**	.23*		
Age	.25*	.35**	-.10	-.31**	-.23*	
Selffit	-.47**	.03	.47**	.37**	.24*	.08
Exerwk	-.19	.05	.46**	.32**	.09	.06
Pawork	.04	-.05	-.11	-.06	-.07	-.01
Pasport	-.20	.22	.38**	.41**	.10	.13
Paleisure	-.20	.11	.08	.08	-.08	-.16
M	75.9	65.0	26.6	35.7	11.8	26.4
SD	34.5	9.1	10.7	9.7	7.2	5.8

Note. The higher the score, the greater the attribution.

*p < .05 **p < .01

Table 1 continued

	Fitness and Exercise Variables				
	Selffit	Exerwk	Pawork	Pasport	Paleisure
MVO2					
HR					
SBP					
DBP					
BMI					
WHR					
SOS					
Grip					
Pushups					
Situps					
Flexion					
Age					
Selffit					
Exerwk	.56**				
Pawork	-.09	-.05			
Pasport	.67**	.63**	-.04		
Paleisure	.15	.20	-.02	.09	
M	2.9	2.7	2.5	2.5	2.9
SD	.9	2.3	7	.8	7

Note. The higher the score, the greater the attribution.

*p < .05 **p < .01

Key for Tables.

HR	Baseline measure in bpm
SBP	Baseline measure in mmHg
DBP	Baseline measure in mmHg
Grip	Muscular strength: grip strength
Pushups	Muscular endurance: maximum push-ups
Situps	Muscular endurance: maximum sit-ups in 1 min.
Flexion	Flexibility: trunk forward flexion
Selffit	Self perception of fitness
Exerwk	Number of times exercise weekly
Pawork	Occupational physical activity
Pasport	Sport during leisure time
Paleisure	Physical activity during leisure time excluding sport
Smoke	No. cigarettes smoked per day
Alcohol	No. alcoholic drinks consumed per week
Conscien	Conscientious of healthy living
Sathealth	Satisfaction with health
Satactiv	Satisfaction with activity level
Dieteff	Effort in maintaining nutritious diet
Tension, Depress, Anger,Vigour, Frustra, Confuse	POMS measures
POMStmd	POMS Total mood disturbance

validity of this set of measures in assessing fitness. The mean MVO2 of this sample is in the below average range for Canadian norms (CSTF, 1986).

MVO2 was significantly correlated with all fitness measures except grip strength, flexibility, occupational physical activity (HPAL work index), and physical activity during leisure time (HPAL leisure index). It was found that simple self-report measures of fitness which themselves intercorrelate (perception of fitness compared to others the same age, number of times the subject exercised per week, and amount of physical activity engaged in as sport; HPAL sport index), correlated highly with MVO2.

In general, measures from the CSTF (BMI, WHR, SOS, grip, push-ups, sit-ups, and flexibility) significantly intercorrelated. Body composition (BMI, WHR, SOS), and muscular endurance (push-ups and sit-ups) are shown to be related to aerobic fitness.

Physical activity as a sport correlates positively with MVO2, muscular endurance, and negatively with resting HR, indicating that the HPAL sport index is measuring an aerobic, endurance component of fitness. On the other hand, occupational physical activity and physical activity during leisure time were not related

to the other measures of aerobic fitness and/or exercise. Low resting HR was significantly correlated with high MVO2 as expected, as well as with the performance of a high number of push-ups, the perception of fitness level, the number of times a week one exercises, and physical activity as sport. Resting SBP and resting DBP correlated negatively with MVO2 and positively with BMI and SOS.

Psychological and Health Measures

Table 2 shows the mean and standard deviations of each psychological and health measure, and the intercorrelations between them. The high number of significant intercorrelations supports the existence of a common general dimension of health and well-being.

Correlations of Fitness to Well-being

As can be seen in Table 3, correlations between fitness and exercise participation indices and the health behaviours and psychological measures reveal few significant relationships between these measures. However, MVO2 was significantly correlated with how conscientious one was in living a healthy life, and how satisfied the subject was with her health and physical activity, lending support for the use of these measures. The performance of sit-ups also related to satisfaction

Table 2

Intercorrelations of Psychological and Health Indices

	Health Behaviours and Psychological Measures					
	Smoke	Alcohol	Conscien	Sathealth	Satactiv	Dieteff
Smoke						
Alcohol	.34**					
Conscien+	.13	.05				
Sathealth+	.16	.02	.52**			
Satactiv+	.13	-.07	.35**	.63**		
Dieteff+	.18	-.11	.50**	.55**	.50**	
Exerwk	-.09	.15	-.24*	-.44	-.63**	-.35**
LSS	.01	.07	.20	.28*	.22*	.27*
PSS	.01	.07	.14	.32**	.33**	.25*
CHIPS	-.04	.11	.31**	.38**	.19	.12
Tension	-.13	.05	.18	.17	.05	-.01
Depress	-.00	.00	.11	.24*	.19	.17
Anger	-.03	.19	.06	.28*	.12	.07
Vigour	-.09	-.03	-.36**	-.36**	-.24*	-.31**
Frustra	-.13	.09	.28*	.38**	.30**	.17
Confuse	-.00	.09	.28*	.36**	.26*	.17
POMStmd	-.05	.10	.26*	.39**	.25*	.19
M	.9	1.8	2.4	2.9	3.4	2.7
SD	2.8	2.0	.8	1.0	1.1	.9

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

Table 2 continued

	Health Behaviours and Psychological Measures				
	Exerwk	LSS	PSS	CHIPS	Tension
Smoke					
Alcohol					
Conscien					
Sathealth					
Satactiv					
Dieteff					
Exerwk					
LSS	-.07				
PSS	-.21	.63**			
CHIPS	-.13	.46**	.45**		
Tension	-.01	.36**	.52**	.53**	
Depress	-.07	.48**	.70**	.46**	.61**
Anger	-.08	.43**	.58**	.56**	.45**
Vigour	.21	-.37**	-.40**	-.31**	-.37**
Frustra	-.24*	.26*	.40**	.66**	.57**
Confuse	-.16	.49**	.71**	.59**	.72**
POMStmd	-.16	.53**	.73**	.68**	.81**
M	2.7	55.7	21.5	14.3	9.1
SD	2.3	17.4	7.5	9.9	5.6

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

Table 2 continued

Health Behaviours and Psychological Measures						
	Depress	Anger	Vigour	Frustra	Confuse	POMStmd
Smoke						
Alcohol						
Conscien						
Sathealth						
Satactiv						
Dieteff						
Exerwk						
LSS						
PSS						
CHIPS						
Tension						
Depress						
Anger	.71**					
Vigour	-.37**	-.22*				
Frustra	.35**	.41**	-.40**			
Confuse	.70**	.60**	-.37**	.58**		
POMStmd	.84**	.76**	-.59**	.70**	.85**	
M	6.6	6.6	17.4	6.7	6.7	118.3
SD	6.9	6.2	5.4	5.3	4.3	25.7

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

Table 3

Correlations Between Fitness and Exercise Behaviours and Psychological and Health Indices

	Health and Psychological Measures					
Fitness & Exercise	Smoke	Alcohol	Conscien+	Sathealth+	Satactiv+	Dieteff+
MVO2	-.11	.10	-.24*	-.38**	-.47**	-.18
HR	.05	.01	.11	.28*	.22*	.14
SBP	.14	.16	-.01	.05	-.02	.01
DBP	.33**	.18	.04	.09	-.06	-.02
BMI	.12	.08	.15	.24*	.20	.04
WHR	.29*	.08	-.04	.11	.12	-.00
SOS	.11	.02	.21	.33**	.32**	.13
Grip	.12	.33**	-.07	-.04	.01	-.07
Pushups	-.21	.05	-.15	-.19	-.41**	-.13
Situps	-.24*	-.04	-.19	-.27	-.43	-.23
Flexion	-.01	-.07	-.13	-.04	-.05	.06
Age	.08	.14	-.13	-.09	-.00	-.13
Selffit	-.12	-.01	-.49**	-.59**	-.64**	-.53**
Exerwk	-.09	.15	-.24*	-.44**	-.63**	-.35**
Pawork	-.01	-.01	-.05	-.00	.03	-.05
Pasport	-.04	.11	-.46**	-.50**	-.63**	-.52**
Paleisure	.05	-.15	-.16	-.15	-.12	-.03

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 3 continued

	Health and Psychological Measures				
Fitness & Exercise	Exerwk	LSS	PSS	CHIPS	Tension
MVO2	.43**	-.04	-.10	-.04	-.03
HR	-.28*	.06	.11	.30**	.01
SBP	.01	-.11	.04	-.05	-.01
DBP	.12	-.09	-.01	-.09	.08
BMI	-.08	-.15	-.05	-.17	-.09
WHR	-.12	-.06	.02	-.16	-.16
SOS	-.19	-.02	.04	-.03	-.05
Grip	.05	-.02	.02	-.20	-.13
Pushups	.46**	.04	-.14	.07	.06
Situps	.32**	-.03	-.21	.01	.01
Flexion	.09	.19	.13	.12	-.00
Age	.06	-.24*	-.16	-.32**	-.11
Selffit	.56**	-.25*	-.25*	-.16	-.04
Exerwk	1.00	-.07	-.21	-.13	-.01
Pawork	-.05	-.10	-.14	-.12	-.07
Pasport	.63**	-.18	-.18	-.11	-.02
Paleisure	.20	.10	-.08	-.24*	-.14

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 3 continued

	Health and Psychological Measures					
Fitness & Exercise	Depress	Anger	Vigour	Frustra	Confuse	POMStmd
MVO2	-.05	-.04	.04	-.11	-.07	-.07
HR	.02	.12	-.04	.14	.18	.10
SBP	.06	.14	.16	-.06	.02	.01
DBP	.10	.10	.15	-.07	-.00	.02
BMI	-.10	-.06	.10	-.09	.01	-.10
WHR	-.17	-.10	.09	-.14	.00	-.15
SOS	.01	.03	-.04	.03	.08	.03
Grip	-.12	-.02	.13	-.11	.01	-.11
Pushups	-.05	-.00	.08	-.10	-.10	-.06
Situps	-.05	-.05	.18	-.18	-.04	-.11
Flexion	.04	.03	.18	-.04	-.02	-.03
Age	-.12	-.02	.06	-.12	-.22*	-.14
Selffit	-.15	-.10	.36**	-.21	-.29**	-.24*
Exerwk	-.07	-.08	.21	-.24*	-.16	-.16
Pawork	-.07	-.04	.02	-.09	-.12	-.09
Pasport	-.05	-.04	.26*	-.27*	-.16	-.16
Paleisure	.13	-.03	.19	-.29**	-.09	-.12

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

with health, activity, effort in eating nutritiously, and not smoking. As well, the self-report measures of perceived fitness level, exercise per week, and physical activity as sport were related to the subjects' conscientiousness of, and satisfaction with, her health behaviours. This indicates that high aerobic fitness and a high level of exercise participation influences women's positive self-perceptions of, and satisfaction with their health.

In general, there is a lack of evidence for psychological benefits of *aerobic* fitness. MVO2 is not related to any psychological indices, except that the higher aerobically fit individuals reported more exertion during the mental stress, a finding opposite to that expected. However, the *perceived* fitness level was related negatively to LSS, PSS, confusion, and mood disturbance, and positively to vigour. *Activity level as sport* was positively related to vigour, and negatively to frustration. This indicates that women who perceive themselves as more fit and report that they participate in a high level of sport, also report that they experience a less negative life situation, less stress in their lives, less confusion, less negative affect, and a higher level of vigour.

HR Reactivity to Stress

Both the psychological and physical stressors were effective in increasing HR. A paired t-test indicated that the HR increase from baseline to the third minute of the mental stressor (M = 9.7) was significant, t = 12.7, df = 76, $p < .01$. A paired t-test showed that the HR increase from baseline to the third minute of the physical stressor (M = 17.4) was also significant, t = 16.0, df = 76, $p < .01$. Mean HR at baseline and at the final (third) minute of both stressors (i.e., the increase in HR in response to the two stressors) is presented in Figure 1.

Correlations with HR Stress Reactivity

As expected, aerobic fitness was negatively correlated with resting HR (r = -.30, $p < .01$). Partial correlations which controlled for baseline HR, were used to analyze the relationships between HR reactivity during the mental and physical stressors (final minute of task) and the fitness and health-related variables, which can be seen in Table 4. Baseline HR was partialled out in order to examine the HR reactivity differences independent of the resting level. In general, fitness and exercise behaviours did not predict HR reactivity to either of the stressors. MVO2 was not

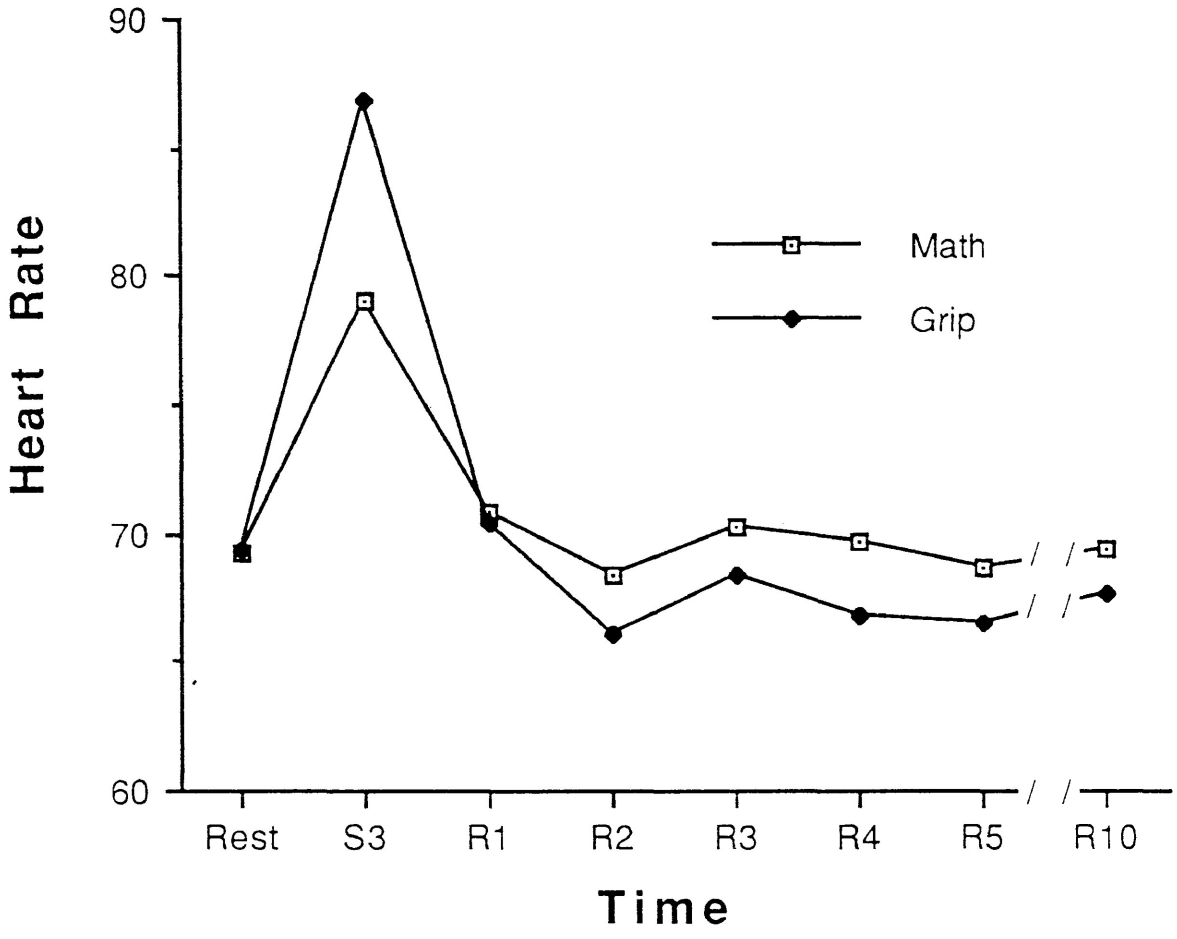

Figure 1. Heart rate recovery following the mental (serial subtraction) and physical (hand grip) tasks.

Table 4

Correlations of Fitness & Heart Rate Response to Stressors

	HR Response in Final Minute of Stress	
Fitness & Exercise	Serial Subtraction	Grip Task
MVO2	.11	.06
Age	-.15	-.24*
BMI	-.16	-.20
WHR	-.32**	.00
SOS	-.16	-.22*
Grip	-.28*	.07
Pushups	.12	-.04
Situps	.21	.20
Flexion	-.09	-.18
Selffit	.14	-.02
Exerwk	.06	-.16
Pawork	.25*	-.04
Pasport	-.00	-.00
Paleisure	-.14	-.05

Note. The higher the score, the greater the attribution.

*$p < .05$ **$p < .01$

related to HR reactivity during the mental or the physical tasks.

There were some unexpected findings in response to the mental task (Table 4). A high WHR was related to a smaller HR response to the mental stressor. A high level of occupational physical activity was related to a large HR response, also a finding opposite to that expected. However, grip strength correlated with a smaller HR response to the stress. In summary, a smaller, and assumed healthier HR response to the stress, was experienced by strong women with a high waist-to-hip ratio, who report less physical activity at work.

The findings for the HR response to the physical stressor are also presented in Table 4. In general, the correlations for the reactivity to the physical stressor show similar minimal relationships to fitness and exercise as do those of the mental stressor. As expected, older subjects displayed less HR reactivity in response to the physical stressor. In a direction opposite to that expected, but similar to the WHR finding above, women with a higher measure of SOS displayed a smaller response to the physical stressor. Women who responded less to the physical stressor,

displaying less stress reactivity, were older with a higher measure of the sum of skinfolds.

Health behaviours also did not show any consistent relationships to HR reactivity to the stressors. In a direction opposite to that expected, smokers were not as physically stressed as nonsmokers, that is, they showed less HR reactivity to the mental stressor (r = -.29, p < .01).

Relationships between psychological measures and the HR reactivity were equally unimpressive. However, those who perceived that they physically exerted themselves to a greater extent on the grip task also showed a larger response to that stress; their perception was correct (r = .26, p < .05).

HR Recovery

A residual score of HR recovery (first 2 minutes of recovery) from both stressors was examined for any relationships to the fitness, health behaviours, and psychological variables. Partial correlations, controlling for the preceding baseline and stress reactivity, did not reveal many significant relationships in the expected direction.

Recovery From the Mental Stressor

Partial correlations for the HR recovery from the

mental stressor is presented in Table 5. Opposite to the expected direction, those who exercise a high number of times weekly displayed a slower recovery to the mental task in the first minute post-task. Higher grip strength correlated with a slower recovery to the mental task as well. Expectedly, individuals with a high PSS score, indicating a greater amount of perceived life stress, experienced a significantly slower recovery to the mental task. In summary, individuals who experienced a faster, and assumed healthier recovery from mental stress, exercise less per week, have a weaker grip strength, and report a low level of life stress.

Recovery From the Physical Stressor

Partial correlations to the HR recovery from the physical task are shown in Table 6. The only relationship with exercise was opposite to that expected; women who reported participating in a high level of physical activity during leisure time exhibited slower HR recovery to the physical task. Meaningful relationships were also lacking with health behaviours. However a surprising finding indicated that drinking more alcoholic beverages weekly is correlated with a faster HR recovery in the first minute from the grip

Table 5

Partial Correlations of Heart Rate Recovery from the Mental Stressor

Recovery	Variables					
	Fitness and Exercise					
	MVO2	BMI	WHR	SOS	Grip	Pushups
Min. 1	.16	.08	-.03	.04	.11	.12
Min. 2	.01	.20	.08	.20	.24*	.07
	Psychological and Health					
	Smoke	Alcohol	Conscien+	Sathealth+	Sataciv+	Dieteff+
Min. 1	-.07	-.05	-.13	-.06	-.08	.01
Min. 2	-.11	-.00	-.07	.17	.12	.15

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 5 continued

Recovery	Variables					
	Fitness and Exercise					
	Situps	Flexion	Age	Selffit	Exerwk	Pawork
Min.1	.01	.04	-.01	.08	.26*	.16
Min. 2	-.13	.05	.20	-.03	.13	-.01
	Psychological and Health					
	LSS	PSS	CHIPS	Tension	Depress	Anger
Min.	.05	.18	-.02	.06	.09	-.05
Min. 2	.20	.34**	-.07	.03	.11	-.05

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 5 continued

Recovery	Variables			
	Fitness and Exercise			
	Pasport	Paleisure		
Min. 1	.01	.08		
Min. 2	-.11	.06		
	Psychological and Health			
	Vigour	Frustra	Confuse	POMStmd
Min. 1	.05	.04	.14	.04
Min. 2	-.02	.04	.14	.05

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 6

Partial Correlations of Heart Rate Recovery from the Physical Stressor

Recovery	Variables					
	Fitness and Exercise					
	MVO2	BMI	WHR	SOS	Grip	Pushups
Min. 1	.07	.02	.10	.03	.01	-.01
Min. 2	.03	.09	.02	.13	.14	.19
	Psychological and Health					
	Smoke	Alcohol	Conscien+	Sathealth+	Sataciv+	Dieteff+
Min. 1	-.04	-.27*	.11	-.09	-.01	-.01
Min. 2	-.10	-.13	.02	.05	.03	-.04

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 6 continued

Recovery	Variables					
	Fitness and Exercise					
	Situps	Flexion	Age	Selffit	Exerwk	Pawork
Min. 1	.01	.05	.04	.01	.10	-.10
Min. 2	.06	.08	.09	-.02	.04	.01
	Psychological and Health					
	LSS	PSS	CHIPS	Tension	Depress	Anger
Min. 1	.07	-.04	-.19	-.17	-.09	-.17
Min. 2	.06	-.07	-.05	-.15	-.15	-.13

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*p < .05 **p < .01

Table 6 continued

Recovery	Variables			
	Fitness and Exercise			
	Pasport	Paleisure		
Min. 1	.04	.22*		
Min. 2	-.06	-.05		
	Psychological and Health			
	Vigour	Frustra	Confuse	POMStmd
Min. 1	.05	-.03	.01	-.11
Min. 2	-.05	-.00	-.06	-.10

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

task.

As the main purpose of the present study was to examine HR recovery, several additional analyses were conducted to explore if a relationship existed but was for some reason not detected in the previous analyses. Scatter diagrams of the relationship between MVO2 and a difference score reflecting HR recovery were examined. No evidence was found in these scatter diagrams for a curvilinear relationship (which might have been expected if benefits of exercise appeared maximally at moderate fitness levels). As well, the scatter diagrams did not indicate the presence of cases in which the predicted relationship might have been observed. A second approach was also used to explore the data further. Because the effects of recovery might have been more apparent in those who had further to recover from, an analysis was conducted with only those subjects who exhibited an increase in HR response to the mental stressor of greater than or equal to 10 beats per minute. This yielded a sample size of 33 subjects. Again, no evidence was found for the predicted relationship. On the contrary, a slow HR recovery to the mental task was correlated with a high MVO2 (r = .39, p < .05), and a high exercise per week score

(r = .36, p < .05) which are opposite to that expected. Inspection of a scatter diagram revealed that these positive relationships were largely due to one outlier. When that case was removed, the relationship disappeared.

Blood Pressure

Partial correlations, which controlled for resting BP, were also used to examine the relationship of health and fitness variables to blood pressure recovery (minutes 1 and 4 post-task) from the mental and physical stressors. These partial correlations are shown in Tables 7 and 8.

Systolic Blood Pressure Recovery

Recovery from the mental stressor. As can be seen in Table 7, MVO2 was associated with faster SBP recovery during the first minute following the mental stressor. However, the only other relationship seen between SBP recovery from the mental stress and an aspect of fitness was opposite to that expected: greater muscular endurance as measured by the performance of push-ups was correlated with a slower SBP recovery. Age correlated with a slower SBP recovery to the mental task, with older subjects showing a slower recovery.

Psychological indices and health behaviours also

Table 7

Partial Correlations of SBP and DBP Recovery to the Mental Stressor

	SBP Recovery (in min.)		DBP Recovery (in min.)	
Variables	1	4	1	4
Fitness and Exercise				
MVO2	-.26*	-.20	-.15	-.08
BMI	.20	.03	-.00	-.05
WHR	-.01	.14	-.13	.08
SOS	.08	.10	-.02	.02
Grip	.15	.10	.00	-.09
Pushups	.21*	.03	-.04	-.14
Situps	-.05	.04	.16	-.07
Flexion	-.15	.08	-.10	-.02
Selffit	.16	-.17	-.06	-.14
Pawork	-.04	-.07	-.10	-.15
Pasport	-.12	.06	-.02	-.09
Paleisure	.10	-.11	-.00	-.16
Exerwk	.15	-.16	.04	-.18

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 7 continued

	SBP Recovery (in min.)		DBP Recovery (in min.)	
Variables	4		4	4
Psychological and Health Behaviours				
Age	.27*	-.03	.15	-.12
Smoke	-.08	.09	-.02	.10
Alcohol	.01	-.02	.12	.12
Conscien+	-.03	.01	.03	.13
Sathealth+	.11	.31**	.08	.07
Satactiv+	-.02	.11	-.01	.10
Dieteff+	.12	.27*	.12	.24*
LSS	-.04	.26*	-.02	.07
PSS	-.07	.18	-.09	.07
CHIPS	-.32**	-.01	-.15	-.06
Tension	-.10	-.04	-.13	-.01
Depress	-.21*	-.01	-.01	.05
Anger	-.21	.02	-.04	.10
Vigour	.05	-.21	-.07	-.13
Frustra	-.15	.04	.03	.04
Confuse	-.21*	-.12	-.09	.04
POMStmd	-.20	.02	-.03	.07

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 8

Partial Correlations of SBP and DBP Recovery to the Physical Stressor

	SBP Recovery (in min.)		DBP Recovery (in min.)	
Variables	'	4	'	4
Fitness and Exercise				
MVO2	-.32**	.11	-.09	-.05
BMI	.25*	-.31**	.07	-.01
WHR	.14	-.02	.02	-.03
SOS	.18	-.36**	.12	.06
Grip	.14	-.09	.08	-.07
Pushups	-.00	.02	.01	-.15
Situps	-.03	.12	-.00	-.01
Flexion	-.07	.04	-.02	-.07
Selffit	-.11	.10	-.11	-.19
Pawork	-.05	-.15	-.22*	-.05
Pasport	-.03	.29**	-.09	-.09
Paleisure	-.07	.12	-.18	-.10
Exerwk	.02	.09	-.17	-.17

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

Table 8 continued

	SBP Recovery (in min.)		DBP Recovery (in min.)	
Variables	1	4	1	4
Psychological and Health Behaviours				
Age	.22*	-.05	-.10	-.17
Smoke	.01	.22*	.04	.18
Alcohol	-.14	.18	-.07	.18
Conscien+	.00	-.08	.10	.21*
Sathealth+	.07	-.03	-.10	.07
Satactiv+	.03	-.08	-.03	.10
Dieteff+	.11	.05	.16	.23*
LSS	-.02	.08	.08	.06
PSS	-.10	.23	-.07	-.00
CHIPS	-.31**	.04	-.07	.01
Tension	-.16	.01	-.19	-.12
Depress	-.22*	.13	-.08	.06
Anger	-.21*	.14	-.09	.07
Vigour	.08	.01	-.01	-.05
Frustra	-.11	-.08	-.08	.15
Confuse	-.23*	-.07	.00	.07
POMStmd	-.21*	.04	-.09	.06

Note. The higher the score, the greater the attribution.

+Scored in reverse, the lower the score, the greater the attribution.

*$p < .05$ **$p < .01$

revealed few significant relationships with the SBP recovery from the mental stress in the expected direction. A high score on the CHIPS, indicating a high number of physical complaints, and negative affect in the form of depression and confusion, were related to faster SBP recovery. An interesting finding was that being less satisfied with one's health, and making less of an effort in adhering to a nutritious diet correlated with a slower SBP recovery to the mental stress.

Recovery from the physical stressor. MVO2 also correlated significantly with faster SBP recovery during the first minute following the physical stressor, as shown in Table 8. However, high physical sport activity was related to a slower SBP recovery to the physical task. Surprisingly, a high SOS measure was correlated with faster SBP recovery as well. As with the recovery from the mental task, age correlated with a slower SBP recovery to the physical task, with older subjects recovering slower.

Psychological and health behaviours again revealed few relationships with SBP recovery from the physical task. As with the SBP recovery from the mental stressor, a high CHIPS score, and negative affect in the form of depression, confusion, anger, and a high total

mood disturbance score correlated with a faster recovery to the physical stressor. As to be expected smoking correlated with a slower SBP recovery to the physical stress.

Summary of SBP findings. It appears that faster SBP recovery to mental and/or physical stress is evidenced by younger females who are more aerobically fit, but possess a larger sum of skinfolds, have a low level of muscular endurance, and report a low level of physical sport activity. Although these women report a large number of physical complaints, and a high level of negative affect, they also indicate that they do not smoke, make an effort in maintaining a nutritious diet, and are more satisfied with their health.

Diastolic Blood Pressure Recovery

MVO2 was not related to DBP; nor were the other fitness and exercise variables clearly related to DBP recovery, as can be seen in Tables 7 and 8.

Discussion

The purpose of the present investigation was to investigate possible psychological and stress-related benefits of fitness and exercise in women. Overall, the

present findings provide very little support for the existence of such benefits. Of particular importance is the present failure to detect faster HR recovery from stress in aerobically fit females. On the other hand, faster SBP recovery from stress in aerobically fit individuals was revealed.

Although the results were generally nonsignificant, the findings from the present study appear to be valid. Findings were analyzed from a large homogeneous sample, of which the members had been screened for previous symptoms of heart disease, medication affecting the cardiovascular system or mood, and English-language comprehension difficulties. Fitness was assessed through a number of measures. The intercorrelations of these fitness and exercise indices were generally high, supporting the validity of these measures for assessing a dimension of fitness. The stressors in the study yielded significant HR increases, indicating that they were, in fact, physiologically stressful. Both a mental stressor and a physical stressor were used to explore whether or not a relationship of fitness to faster physiological recovery would be more evident with a physical task. However, HR recovery did not show a relationship to fitness level even from the physical

task. As well, contrary to Reid's (1990) findings, even simple self-reported measures of fitness did not predict HR recovery from either the mental or the physical task. In fact, some findings from the present study were opposite to that expected, in that those who indicated exercising more per week recovered slower (HR) from the mental task, and those reporting more physical activity during leisure time had a slower HR recovery to the physical task.

Psychological Benefits

It is generally believed by those who exercise that they are gaining psychological benefits (Sime, 1984). However, the present study is consistent with results of similar investigations in failing to reveal an association between aerobic fitness and improved mood (e.g., Ford et al., 1989; Lennox et al., 1990).

Nevertheless, the present findings do indicate that women who are aerobically fit have more positive perceptions of their fitness level and health behaviours (i.e., they perceive themselves as being fit, are more conscientious in living a healthy lifestyle, and are more satisfied with their health and activity levels), as well as participating in a high level of exercise per week, and in a high level of physical activity as sport.

In other words, this study supports previous studies which have found that the main benefits of fitness and exercise relate directly to the physical benefits observed with exercise participation (Agnew & Levin, 1987; King et al., 1989; Kowal et al., 1979; Ross & Hayes, 1988). While the benefits of MVO2 were minimal (higher exercise level, positive perceptions of personal health behaviours), it is perhaps important to note the self-reported level of fitness was more strongly related to psychological benefits. This finding would be worth pursuing and may indicate that MVO2 is not the best measure of the psychological benefits of exercise. For the women observed in the present study, being physically fit may stem from their conscientiousness in living a healthy lifestyle, and lend to their personal satisfaction with their health and activity levels. The conclusion may be that exercising and being physically fit is just one of many avenues by which one can achieve a happy and healthy lifestyle (Belloc & Breslow, 1972).

HR Recovery

On the basis of the present findings, the conclusion appears to be that faster HR recovery from stress is (a) not a robust finding which is easily demonstrated, and (b) is not particularly evident in the

female population studied. The findings in this study are consistent with other recent investigations. In general, fitness and exercise behaviours did not predict HR recovery from either of the stressors. With a similar sample of female subjects, Long (1991) also failed to find an effect of fitness level and stress recovery when controlling for baseline HR. Other research has also found that high fit male and/or female subjects do not display smaller HR response to (Duda, Sedlock, Melby, & Thaman, 1988) or faster HR recovery from stressors (Brooke & Long, 1987; de Geus et al., 1990; Hull, Young, & Ziegler, 1984; Jamieson & La Voie, 1987; Sinyor, Peronnet, Brisson, & Seraganian, 1988). The present results fail to clarify the circumstances from which a relationship between fitness and cardiovascular recovery from stress might appear.

Systolic Blood Pressure

One finding in the present study consistent with a positive benefit of fitness is the faster SBP recovery from stress. SBP has generally been found to be a more sensitive measure than HR or DBP to factors related to coronary heart disease (e.g., Manuck, Kasprowicz, Monroe, Larkin, & Kaplan, 1989). As SBP was not measured during the tasks, a caution must be raised.

The present findings could indicate either a faster recovery, or a continuance of a smaller BP reaction, to the stressors. While the present design did not permit a separation of the BP reaction/recovery, this finding is still clearly evidence for a benefit of exercise in the form of decreased SBP reactivity and/or faster SBP recovery in response to stress in aerobically fit females.

Other Issues

The present study used a cross-sectional approach to explore possible benefits of exercise and fitness in women. While such correlational designs are generally acknowledged to be poor methods for evaluating cause and effect relationships, recent advances in path analysis provide a basis for evaluating possible mechanisms which may underlie any relationship observed (Jamieson & Flood, 1991). In the present study, it was anticipated that the results would be analyzed with path analysis, however this approach was not used as the findings were generally nonsignificant. In particular, no evidence was found to support Dienstbier's (1989) theory of physiological toughness. Faster HR recovery from stress was not associated with dimensions characterizing the concept of physiological toughness (low resting HR,

aerobic fitness, and other indices of fitness, exercise, healthy practices, and positive affect). Also to be explored through path analysis, was the issue concerning whether faster physiological recovery mediated psychological benefits. Since these benefits of fitness were not supported, exploring underlying variables such as fast recovery was not indicated.

The present study employed a large number of variables from which one would expect a considerable incidence of Type 1 errors. A number of the health and fitness measures were found to be related to cardiovascular reactivity, but because of the large number of relationships explored and the small number of significant results, it is more appropriate not to draw conclusions from these sporadic findings.

Future Research

On the other hand, there are findings from the present study which can yield directions for future research. For example, it would be interesting to explore further the variables which were related to a smaller reactivity to, and a faster recovery from stress. If this type of cardiovascular pattern is in fact healthier, developing a profile of a woman who reacts to stress in this manner may shed light on what

is important in maintaining health. In the present study, the profile created of women who show smaller SBP responses and/or faster SBP recovery to stress, is of younger women who are more aerobically fit, but possesses a high fat percentage (SOS), have a low level of muscular endurance, and report a low level of physical sport activity. These women also indicate that they do not smoke, make an effort in maintaining a nutritious diet, and are more satisfied with their health. (However they also report a large number of physical complaints, and a high level of negative affect.) In addition, the women displaying a smaller HR response and/or faster HR recovery to stress, are characterized as being older, have a higher fat composition (WHR and SOS), report less physical activity at work and in leisure time, exercise less per week, report a low level of life stress, drink alcohol, and smoke. Other than the smoking variable (related to the HR response), these patterns may describe women who are living more moderate lifestyles. This could point to research into lifestyles of moderation rather than intensely active lifestyles for benefits of health, psychological well-being, and cardiovascular recovery from stress.

Summary

In conclusion, the present study attempted to investigate the psychological and health-related benefits of exercise and fitness using a large sample of female subjects. Only minimal support was found for the existence of such benefits. An increase in satisfaction with one's health behaviours, and a positive perception of one's fitness level was related to one's aerobic fitness level and exercise behaviours. The only clear cardiovascular benefit of fitness in reacting to stress was a faster SBP recovery. These findings are not inconsistent with other recent investigations, and suggest caution in concluding that exercise yields or mediates clear psychological and stress-related benefits.

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Appendix A

Physical Activity Readiness Questionnaire (PAR-Q)

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 answer YES or NO to the following questions as they apply to you.

1. Has your doctor ever said you have heart trouble?
2. Do you frequently have pains in your heart and chest?
3. Do you often feel faint or have spells of severe dizziness?
4. Has a doctor ever said your blood pressure was too high?
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?
6. Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to?
7. +Are you pregnant?

* Instructions were modified for use over the telephone
\+ Question 7, asking if the subject was over 65 years of age was substituted with this question which was more relevant to the population studied

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- PAR-Q Validation Report, B.C. Ministry of Health, 1978

- Produced by the B.C. Ministry of Health and the Department of National Health & Welfare

Appendix B

Health Behaviours Questionnaire

Name:_____

Age:_____

Marital Status:_____

1. Compared to other women your age, how physically fit would you say you are?

much less fit	less fit	as fit	more fit	much more fit
1	2	3	4	5

2. On average, how many times in a week do you exercise vigorously for a 20 minute period?

_____

3. How many cigarettes/cigars do you smoke on average per day?

_____

4. How many cups of coffee, tea, or pop (decaffeinated not included) do you drink on average per day?

_____

5. How many alcoholic beverages do you drink on average per week?

_____

6. Do you take any of the following types of pills?

   (a) Medicine for the heart or blood pressure? YES or NO

   (b) Oral contraceptives (either as a method of birth control, to regulate your menstrual cycle, or for another reason)? YES or NO

   (b) Other medicines or drugs? YES or NO

   - if yes, please specify:_____

7. When was your last period?

_____

8. Are you currently pregnant? YES, NO, DON'T KNOW

- if so, by how many months?_____

9. In general, how conscientious are you in living a healthy life?

very conscientious	fairly conscientious	conscientious	not too conscientious	not at all conscientious
1	2	3	4	5

10. How satisfied are you with your health? Would you say you are:

very satisfied	fairly satisfied	satisfied	not too satisfied	not at all satisfied
1	2	3	4	5

11. Do you feel that you get as much physical activity as you need?

very satisfied	fairly satisfied	satisfied	not too satisfied	not at all satisfied
1	2	3	4	5

12. How much effort do you make in adhering to a nutritious and balanced diet?

extreme effort				no effort
1				5

Appendix C

Habitual Physical Activity Level (HPAL)

1. What is your main occupation? _____
   1 3 5

	never	seldom	sometimes	often	always
2. At work I sit	1	2	3	4	5
3. At work I stand		2	3	4	5
4. At work I walk		2	3	4	5

	never	seldom	sometimes	often	very often
5. At work I lift heavy loads	1	2	3	4	5

	very often	often	sometimes	seldom	never
6. After working I am tired	5	4	3	2	
7. At work I sweat	5	4	3	2	

8. In comparison with others my own age, I think my work is physically

   5. much heavier 4. heavier 3. as heavy 2. lighter 1. much lighter

9. Do you play sport? Yes No

   If yes:

   Which sport do you play most frequently?_____

How many hours a week?	<1	1-2	2-3	3-4	>4
How many months a year?	<1	1-3	4-6	7-9	>9

   If you play a second sport, which sport is it?_____

How many hours a week?	<1	1-2	2-3	3-4	>4
How many months a year?	<1	1-3	4-6	7-9	>9

10. In comparison with others my own age, I think my physical activity during leisure time is

much more	more	the same	less	much less
5	4	3	2	1

	very often	often	sometimes	seldom	never
11. During leisure time I sweat	5	4	3	2	1

	never	seldom	sometimes	often	very often
12. During leisure time I play sport	1	2	3	4	5
13. During leisure time I watch television		2	3		5
14. During leisure time I walk		2	3	4	5
15. During leisure time I cycle		2	3	4	5

16. How many minutes do you walk and/or cycle per day to and from work, school, and shopping?

<5	5-15	15-30	30-45	>45
1	2	3	4	5

Codes

9. Sport

Intensity 0.76 - 1.26 - 1.76

Time 0.5 - 1.5 - 2.5 - 3.5 - 4.5

Proportion 0.04 - 0.17 - 0.42 - 0.676 - 0.92

Calculation of the simple sport-score (I9):
(a score of zero is given to people who do not play a sport)

I9 = SUM (intensity x time x proportion)

= 0 / 0.01 - <4 / 4 - <8 /8 - <12 / 12+

1 2 3 4 5

Calculation of scores of the indices of physcial activity:

Work index = [I1 + (6 - I2) + I3 + I4 + I5 + I6 + I7 + I8]/8

Sport index = [I9 + I10 + I11 + I12]/4

Leisure-time index = [(6 - I13) + I14 + I15 + I16]/4

Appendix D

Cohen-Hoberman Inventory of Physical Symptoms (CHIPS)

Directions: Circle the number for each statement that best describes how much that problem has bothered or distressed you during the past two weeks including today. Circle only one number for each item. At one extreme 0 means that you have not been bothered by the problem. At the other extreme, 4 means that the problem has been an extreme bother.

0 Not at all
1 A little bit
2 Moderately
3 Quite a bit
4 Extremely

How much were you bothered by:

1. Sleep problems (can't fall asleep, wake up in middle of night or early in a.m.)..				
2. Weight change (gain of loss of 5 lbs. or more).....	0			4
3. Back pain.....	0	2	3	4
4. Constipation.....	0	2	3	4
5. Dizziness.....	0	2	3	4
6. Diarrhea.....	0	2	3	4
7. Faintness.....	0	2	3	4
8. Constant fatigue.....	0	2	3	4
9. Headache.....	0	2	3	4
10. Migraine headache.....	0	2	3	4
11. Nausea and/or vomiting.....	0	2	3	4
12. Acid stomach or indigestion.....	0	2	3	4
13. Stomach pain (e.g., cramps).....	0	2	3	4

0 Not at all
1 A little bit
2 Moderately
3 Quite a bit
4 Extremely

---

14. Hot or cold spells	0	1	2	3	4
15. Hands trembling	0		2	3	4
16. Heart pounding or racing	0		2	3	4
17. Poor appetite	0		2	3	4
18. Shortness of breath when not exercising or working hard	0		2	3	
19. Numbness or tingling in parts of your body	0		2	3	4
20. Felt weak all over	0		2	3	4
21. Pains in heart or chest	0		2	3	4
22. Feeling low in energy	0		2	3	4
23. Stuffy head or nose	0		2	3	4
24. Blurred vision	0		2	3	4
25. Muscle tension or soreness	0		2	3	4
26. Muscle cramps	0		2	3	4
27. Severe aches and pains	0		2	3	4
28. Acne	0		2	3	4
29. Bruises	0		2	3	4
30. Nosebleed	0		2	3	4
31. Pulled (strained) muscles	0		2	3	4
32. Pulled (strained) ligaments	0		2	3	4
33. Cold or cough	0		2	3	4

Appendix E

Borg's Rate of Perceived Exertion Scale (RPE-Scale)

6	**No exertion at all**
7	
	Extremely light
8	
9	**Very light**
10	
11	**Light**
12	
13	**Somewhat hard**
14	
15	**Hard (heavy)**
16	
17	**Very hard**
18	
19	**Extremely hard**
20	**Maximal exertion**

Appendix F

Perceived Stress Scale (PSS)

Directions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

For each question choose from the following alternatives:

0 never
1 almost never
2 sometimes
3 fairly often
4 very often

---

1. In the last month, how often have you been upset because of something that happened unexpectedly?

2. In the last month, how often have you felt that you were unable to control the important things in your life?

3. In the last month, how often have you felt nervous and "stressed"?

4. In the last month, how often have you dealt successfully with irritating life hassles?

5. In the last month, how often have you felt that you were effectively coping with important changes that were occuring in your life? 0

6. In the last month, how often have you felt confident about your ability to handle your personal problems?

7. In the last month, how often have you felt that things were going your way?

For each question choose from the following alternatives:

0 never
1 almost never
2 sometimes
3 fairly often
4 very often

8.	In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
9.	In the last month, how often have you been able to control irritations in your life?					
10.	In the last month, how often have you felt that you were on top of things?					
11.	In the last month, how often have you been angered because of things that happened that were outside of your control?					
12.	In the last month, how often have you found yourself thinking about things that you have to accomplish?					
13.	In the last month, how often have you been able to control the way you spend your time?					
14.	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?					

Appendix G

Life Situation Survey (LSS)

Instructions: A number of statements which concern different aspects of your present life situation are listed below. Read each statement and indicate the extent to which you agree or disagree with it by circling the appropriate number in the right margin. You will note that there are six possible ratings: 1. agree very strongly, 2. agree strongly, 3. agree, 4. disagree, 5. disagree strongly, and 6. disagree very strongly. Do not spend too much time on each item, but try to reflect your true feelings.

1. I feel safe and secure..... 6
2. My health is good..... 6
3. I have too few friends who I can count on.. 6
4. I like myself the way I am..... 5 6
5. I am better off than most people in Canada. 5 6
6. I feel constantly under pressure..... 5 6
7. I don't eat very well..... 5 6
8. My future is hopeless..... 5 6
9. I am a happy person..... 5 6
10. There are always people willing to help me when I really need it..... 6
11. My income is a constant source of worry.. 6
12. My sleep is restful and refreshing..... 6
13. I don't get the love and affection I need.. 6
14. I don't have any fun or relaxation..... 6
15. Services provided by government and other public agencies meet my needs..... 6
16. I am able to go when and where I need to go 6
17. I am satisfied with my employment (or school if you are primarily a student).....
18. There is little that I am able to enjoy in my community and surroundings..... 6
19. I am exhausted well before the end of the day 1 2 3 4 5 6
20. I have too little control over my life... 1 2 3 4 5 6

Appendix H

Profile of Mood States (POMS)

Below is a list of words that describe feelings people have. Please read each one carefully. Then circle ONE number corresponding to the adjective phrase which best describes HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY.

	Not at all	A Little	Moderately	Quite A bit	Extremely
1. Friendly	0		2	3	4
2. Tense	0		2	3	4
3. Angry	0		2	3	4
4. Worn out	0		2	3	4
5. Unhappy	0		2	3	4
6. Clear-headed	0		2	3	4
7. Lively	0		2	3	4
8. Confused	0		2	3	4
9. Sorry for things done	0		2	3	4
10. Shaky	0		2	3	4
11. Listless	0		2	3	4
12. Peeved	0		2	3	4
13. Considerate	0		2	3	4
14. Sad	0		2	3	4
15. Active	0		2	3	4
16. On edge	0		2	3	4
17. Grouchy	0		2	3	4
18. Blue	0		2	3	4

	Not at all	A Little	Moderately	Quite A bit	Extremely
19. Energetic	0		2	3	4
20. Panicky	0		2	3	4
21. Hopeless	0		2	3	4
22. Relaxed	0		2	3	4
23. Unworthy	0		2	3	4
24. Spiteful	0		2	3	4
25. Sympathetic	0		2	3	4
26. Uneasy	0		2	3	4
27. Restless	0		2	3	4
28. Unable to concentrate	0		2	3	4
29. Fatigued	0		2	3	4
30. Helpful	0		2	3	4
31. Annoyed	0		2	3	4
32. Discouraged	0		2	3	4
33. Resentful	0		2	3	4
34. Nervous	0		2	3	4
35. Lonely	0		2	3	4
36. Miserable	0		2	3	4
37. Muddled	0		2	3	4
38. Cheerful	0		2	3	4
39. Bitter	0		2	3	4
40. Exhausted	0		2	3	4
41. Anxious	0		2	3	4
42. Ready to fight	0		2	3	

	Not at all	A Little	Moderately	Quite A bit	Extremely
43. Good natured	0	1	2	3	4
44. Gloomy	0		2	3	4
45. Desperate	0		2	3	4
46. Sluggish	0		2	3	4
47. Rebellious	0		2	3	4
48. Helpless	0		2	3	4
49. Weary	0		2	3	4
50. Bewildered	0		2	3	4
51. Alert	0		2	3	4
52. Deceived	0		2	3	4
53. Furious	0		2	3	4
54. Efficient	0		2	3	4
55. Trusting	0		2	3	4
56. Full of pep	0		2	3	4
57. Bad-tempered	0		2	3	4
58. Worthless	0		2	3	4
59. Forgetful	0		2	3	4
60. Carefree	0		2	3	4
61. Terrified	0		2	3	4
62. Guilty	0		2	3	4
63. Vigorous	0		2	3	4
64. Uncertain about things	0		2	3	4
65. Bushed	0		2	3	4

Appendix I

Adult Consent and Release Form for the CSTF

I, the undersigned, do hereby acknowledge:

- my consent to perform a fitness test consisting of *cycling on a bicycle at speeds appropriate for my age and gender, measurements of standing height, weight, girths and skinfolds and tests of grip strength, push-ups, trunk forward flexion and sit-ups, the results of which will assist in determining the type and amount of physical activity most appropriate for my level of fitness;

- my understanding that the heart rate and blood pressure will be measured prior to and at the completion of the test;

- my consent to the tests conducted by an appraiser who has been trained to administer the Canadian Standardized Test of Fitness. I understand that the interpretation of results is limited to providing a comparison with percentile-based norms and information on various aspects of fitness.

- my understanding that there are potential risks; i.e., episodes of transient lightheadedness, fainting, abnormal blood pressure, chest discomfort, leg cramps and nausea, and that I assume willfully those risks;

- my obligation to immediately inform the appraiser of any pain, discomfort, fatigue or any other symptoms that I may suffer during and immediately after the testing;

- my understanding that I may stop or delay any further testing if I so desire and that the testing may be terminated by the appraiser upon observation of any symptoms of distress or abnormal response;

- my understanding that I may ask any questions or request further explanation or information about the procedures at any time before, during and after the testing;

- that I have read, understood, and completed the Physical Activity Readiness Questionnaire and the answers to all the questions were negative:

- that I hereby release the Department of Psychology and the School of Physical Education and Athletics, Lakehead University, its agents, officers and employees from any

liability with respect to any damage or injury (including death) that I may suffer during the administration of the Canadian Standardized Test of Fitness except where the damage or injury is caused by the negligence of the Department of Psychology and/or the School of Physical Education and Athletics, Lakehead University, or its agents, officers and employees acting within the scope of their duties.

_____ _____

Signature Date

_____ _____

Witness Date

NOTE: This form must be witnessed at the time of signing and the witness must be of the age of majority.

* Astrand Bicycle Test was used instead of the Step Test to assess aerobic power for the purposes of this study

Appendix J

Study Consent Form

I, _____ consent to take part in a study conducted by members of the Department of Psychology and the School of Physical Education. This study is concerned with health, physical fitness, and the heart rate response to physical and mental tasks.

In this first phase, I understand that I will be asked to participate in the Canadian Standardized Test of Fitness, which includes exercising on a bicycle while my heart rate is recorded. This exercise is of only moderate intensity, and the experience will not be dangerous for a normal healthy person. During the second phase of the study I will be asked to perform a mental activity while my heart rate is recorded. I am aware that I may or may not find the task difficult. If at any time I wish to discontinue either experimental session, I may indicate this to the experimenter and I will be free to leave.

I understand that the findings from this study will be confidential, and that within a few months of the study's completion, I will receive by mail a summary of the findings from the study. I will receive information about my own fitness level following the second session.

Signed:_____ Date:_____

Appendix K

The Canadian Standardized Test of Fitness Procedure
(from the CSTF Operations Manual, 3rd edition, 1986)

1. Preliminaries: Administer PAR-Q
   consent and release form signed

2. Resting HR Measurement
   - taken after a 5 minute rest period
   - determined using 15 second count and recorded in bpm
   - HR not to be more than 100 bpm for fitness appraisal to be conducted

3. Resting BP Measurement
   - recorded to nearest 2 mmHg
   - for fitness test SBP not to be more than 150 mmHg, DBP not to be higher than 100 mmHg, participant not to be on medication for high blood pressure

4. Anthropometric Measurements
   - Standing height
     - metric tape placed vertically against wall, even with floor
     - subject stands erect against wall, without footwear
     - set square placed on head, mark is made at lower border of square on wall
     - height recorded to nearest .5 cm
   - Girth measurements
     - subjects stands erect in relaxed manner, arms hanging by sides
     - all measures recorded to nearest .1 cm

   a. chest girth - tape positioned around the chest, approximately mid level of the sternum, with arms down, reading taken at end of normal expiration
   b. waist (abdomen) girth - tape positioned at waist, reading is made at end of normal expiration
   c. hip (gluteal) girth - with feet together, tape positioned around hips at greatest gluteal protuberance
   d. right thigh girth - with feet slightly apart, tape positioned around right thigh to a level of 1 cm below the gluteal line

5. Skinfold Measurements
   - each skinfold is measured twice, all from the right side of the body

- the fold of skin and underlying fat is grasped between thumb and forefinger with back of hand facing appraiser
- jaws of calipers kept a right angles to the body surface, contact of calipers placed 1 cm below point where skinfold is raised
- while maintaining pressure of fingers on skinfold, trigger of calipers is fully released, measure is noted when indicator stabilizes, to the nearest .2 mm
- mean of 2 measures recorded, unless difference is greater than .4 mm, then measure a third time

a. triceps skinfold - taken on back of right arm at point midway between tip of shoulder and tip of elbow skinfold raised so fold runs vertically along midline of back of arm
b. biceps skinfold - measured on extended upper arm at same level as triceps, skinfold raised so runs vertically along midline of front of arm
c. subscapular skinfold - with shoulders relaxed, skinfold is raised to be measured on a diagonal line from the vertebral border of scapula to 1 cm below the inferior angle (skinfold runs downward and outward at a 45 degree angle to the spine
d. iliac crest skinfold - right arm raised horizontally, with right hand extended or on right shoulder
   - skinfold measured 3 cm above crest of ilium at midline of body so that fold runs forward and slightly downward
e. medial calf skinfold - participant places relaxed right foot flat on a step, knee at 90 degree angle
   - skinfold raised on inside of right calf above maximum calf girth, fold is vertical along midline

The Astrand Bicycle Test of Aerobic Fitness was substituted for the Canadian Aerobic Fitness Test.

7. Grip Strength
   - grip between fingers and palm at thumb base
   - grip adjusted so second joint of fingers fits snugly under the handle
   - subject holds dynamometer in line with forearm at thigh level
   - dynamometer squeezed to exert maximum force while exhaling
   - both hands measured alternatively, twice each, mean grip for both hands recorded

8. Push-Ups
   - not performed by those with lower back problems

- performed consecutively without a time limit
- lying on stomach legs together, hands pointing forward positioned under shoulders
- subject pushes up by fully straightening elbows, knees as pivotal point, lower legs remaining in contact with mat, upper body in straight line
- subject returns, chin to mat

9. Trunk Forward Flexion
   - not performed by those with lower back problems
   - warm-up with stretching first
   - barefoot, subject sits with legs extended against horizontal crossboards of flexometer
   - knees extended, arms stretched, palms down, the subject bends and reaches forward (without jerking), pushing slider forward along scale with fingertips
   - position of maximum flexion must be held 2 seconds
   - repeat the test twice

10. Sit-ups
    - not performed by those with lower back problems
    - subject lies on back, knees bent at right angle, feet shoulder-width apart
    - hands placed at side of head, fingers over ears, elbows pointed towards knees
    - ankles held by appraiser so that heels are kept in contact with the floor
    - subject to sit up, touch knees with elbows, and return to starting position
    - performs as many as possible in 1 minute

Appendix L

The Astrand Bicycle Test Procedure

1. When using a nonconstant bike ergometer start the metronome at 100 bpm.
2. Ask subject to begin cycling at the proper cadence (50 revolutions per minute).
3. Once the subject has achieved the proper cadence, increase the power level to the prescribed setting (based on age and subjective assessment of fitness level) by turning the force knob. Approximate choice of initial workload = 150 kpm (ergometer at .5).
4. Start timing when the subject has achieved the proper cadence, and the technician has adjusted the prescribed power level.
5. Auscultate and time 30 heart beats starting at 1:30 of the test. This is repeated at 1-minute intervals through the last (sixth) minute of the test.
6. Record the 30-beat time (30-b t), and calculate the heart rate: HR (b/min-1)= 60s x (30 b/30-b t).
7. Readjust the power level by increasing or decreasing it after the 2-minute heart rate if the heart rate target zone is unlikely to be achieved.
8. Appropriate Heart Rates:

   (a) HR from the 5th and 6th minutes should not differ by

more than 10 bpm, if this difference is exceeded the subject should continue cycling until the difference is 10 or less.

(b) HR from minutes 5 and 6 are averaged to get the "steady state HR".

(c) Target HR for this sample is 150 - 160 bpm for women under 30 years of age, and 145 - 155 bpm for women over 30 years.

9. Instead of slowly decreasing the exercise level for a cool down, as suggested by the CSTF protocol, subjects were asked to cease pedalling to allow for the measurement of their cardiovascular recovery from the exercise.

10. Equation method of calculating MVO2:

The final two HRs of the exercise test are averaged to determine the steady state HR, which is used in the following calculations. The Astrand-Ryhming nomogram (1960) is based on the ratio between the submaximal oxygen consumption (VO2sm) and maximal oxygen consumption (VO2max). The ratio was expressed in terms of maximal (HRmax) and submaximal (HRsm) heart rates and put into equation form. Two equations are presented below, the generalized form (Shephard, 1972), and one recommended to employ when testing women (Mahar et al, 1985). Both are presented for an understanding of the latter equation, which was used in the

present study.

Generalized equation:

VO2max (L.min -1) = VO2 x [(HR Range)/(HRsm Range)]

Equation for women:

VO2max (L.min -1) = VO2 x {[(220 - age) - 72]/(HRsm - 72)}

Where:

VO2 = L of oxygen required for the given level of power used during the Astrand Bicycle Test (found in available tables or further equations, Astrand & Ryhming, 1954)

HR Range = HRmax (known value, or 220 - age) minus resting HR (women = 72).

HRsm = the steady state HR (bpm) during the Astrand Bicycle Test

To calculate MVO2, insert the values of maximal HR, submaximal HR elicited during Astrand Bicycle Test, and the submaximal oxygen consumption (VO2) value for the power level that elicited the submaximal HR.

11. Calculations for the weight-adjusted VO2max: For the purpose of comparison, the nomogram values were adjusted to account for differences in body weight (Astrand & Ryhming, 1954; de Geus et al., 1990).

Relative VO2max (mL.kg -1 min -1) = [VO2max (L.min -1) x 1,000]/kg