National Library
of Canada

Bibliothèque nationale
du Canada

Canadian Theses Service

Services des thèses canadiennes

Ottawa, Canada
K1A 0N4

CANADIAN THESES

THÈSES CANADIENNES

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30.

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

NL-339 (r.86/06)

Canadä

THE UNIVERSITY OF ALBERTA

FITNESS AND BODY COMPOSITION PROFILES OF EDMONTON MASTERS SWIMMERS

BY

CAROLYN GAIL HARRIS

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

DEPARTMENT OF PHYSICAL EDUCATION
AND SPORT STUDIES

EDMONTON, ALBERTA

SPRING 1986

ISBN 0-315-30222-4

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: Carolyn Harris

TITLE OF THESIS: Fitness and Body Composition Profiles of Edmonton Masters Swimmers.

DEGREE: Master of Science

YEAR DEGREE GRANTED: 1986

Permission is hereby granted to THE UNIVERSITY OF ALBERTA LIBRARY to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

Carolyn Harris
(Student's signature)

2555 [illegible] Place
(Student's permanent address)

Regina Sask

DATE: April 8 1986

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate studies and Research for acceptance, a thesis entitled "FITNESS AND BODY COMPOSITION PROFILES OF EDMONTON MASTERS SWIMMERS" submitted by CAROLYN GAIL HARRIS in partial fulfilment of the requirements for the degree of Master of Science.

(Supervisor)

E.A. Holdaway

R Macnab

Date April 8 1982

ABSTRACT

The purposes of this study were to develop an anthropometric and performance profile on Edmonton Masters Swim Club members and to examine the relationships between their cardiovascular fitness, body composition, and sports involvement.

Body fat was estimated hydrostatically. Females had higher fat values than males. Percentage body fat values increased with age. Somatotyping (Heath-Carter, 1975) revealed that the females were predominately mesomorphic endomorphs and the males were predominately endomorphic mesomorphs. The Balke-Ware (1959) treadmill test indicated that the males had a higher cardiovascular fitness level than the females. Resting heart rates were slightly lower in the males. With respect to swim performance, the male Masters were faster than the females. The younger Masters tended to be technically more skilled and faster than the older Masters. Males were more involved in Masters Swimming than the females. They were about equal in total sports involvement.

Examination of intervariable relationships revealed a high negative correlation between body fat and cardiovascular fitness and a high positive correlation between the members current level of sports involvement and that of the last two years.

AGKNOWLEDGEMENTS

I would like to thank:

Miss P. Conger, Dr. E. Holdaway, Dr. R. Macnab and Mrs. S. O'Brien. Their knowledge, advise and time was very much appreciated.

My Family; for their positive support and encouragement.

Tim Harris; for his help over all of the trouble spots.

Brian Rein; for his companionship, support and patience.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Today, adult health is a major concern because the proportion of seniors in the population is increasing (Vallbona and Baker,1984). Exercise has been suggested as one method to reduce the incidence of cardiovascular disease that is associated with aging (Bruce,1984). However, proof that exercise delays the effects of aging is lacking, and studies are now being undertaken to discover to what extent exercise can be benefical.

One method of assessing the effects of physical activity is to compare people already involved in a program with those starting to get involved. Although descriptive studies do not provide cause and effect information, they can focus attention on the appropriate questions and help in the formation of a research design that will disclose cause and effect relations.

Masters sports are becoming more and more popular. Adults want to stay active in the sport that they participated in during their youth and they want to compete against their peers. Masters sports are attracting new members . They provide an opportunity for adults to learn a sport and competition is low-keyed. People are classified by ability and/or by age. Emphasis is placed upon both performance improvement and having a good time.

Evidence of the increasing popularity in adult sport is the development of the 1985 World Masters Games. Approximately ten thousand athletes competed in Toronto in twenty-two different sports including swimming.

Masters swimming was developed to keep ex-swimmers, who no longer wanted to participate as age group competitors, active in their sport at a reduced commitment level. Any one over the age of twenty can train with a masters club and compete locally. Masters swimmers are not allowed to return to the age group program as competitors. The rule that one must be over the age of twenty-five in order to compete nationally or internationally is meant to discourage age group swimmers from entering the Masters program prematurely.

Masters swimming has also included other adults who have an interest in swimming but no previous swim competition experience. In Canada, Masters swimming promotes itself as offering fitness, fun and a chance to improve one's swimming ability.

Organized competitive swimming for adults is relatively new (the first U.S. National Masters Swim Meet was held in 1970). The review of the literature did not warrant the statement of an hypothesis. The two purposes of this study were as follows:

1. To examine the relationship among cardiovascular fitness, body composition and involvement in sport.

2. To develop an anthropometric and performance profile on Masters swimmers relative to age and sex.

LIMITATIONS

1. The sample was volunteer.
2. The subjects had to rely on memory for sports history and additional sports involvement questionnaire.
3. The temperature and humidity were not controlled during the testing sessions.
4. The subjects volunteered to be tested at their convenience: therefore, there was no control on previous activity, such as eating and exercising.

DELIMITATIONS

1. The sample consisted of swimmers from the Edmonton Masters Swim Club.
2. The measurements were limited to sport involvement, swim performance as assessed by the coaches, cardiovascular fitness, and anthropometric measures.

DEFINITION OF TERMS

Sport Involvement - any athletic activity participated in with regular frequency during at least one season of the year.

Masters Swimmer - Any person over the age of twenty, registered with the Canadian Amateur Swim Association as a Masters.

Vital Capacity - the maximum volume of air that can be expired after a maximal inspiration.

Residual Volume - the amount of air that remains in the lungs after a maximum expiration.

Somatotyping - a numerical method of describing the human physique in terms of endomorphy, mesomorphy and ectomorphy.

Endomorphy - the first component of a somatotype. Refers to the relative fatness of a physique.

Mesomorphy - the second component of a somatotype. Refers to the relative musculo-skeletal development.

Ectomorphy - the third component of a somatotype. Refers to the relative linearity of a physique. It evaluates the form and longitudinal distribution of endomorphy and mesomorphy.

Operational Somatotype Categories - a somatochart (Figure 1) provides a two-dimensional schematic representation of somatotypes. The following categories are the names of the regions of the somatochart (Carter,1975).

Balanced endomorphy: the first component is dominant and the second and third components are equal. (or do not differ by more than one-half unit).

Mesomorphic endomorph: endomorphy is dominant and the second component is greater than the third.

Mesomorph-endomorph: the first and second components are equal (or do not differ by more than one-half unit) and the third component is smaller.

Endomorphic mesomorph: the second component is dominant and the first component is greater than the third component.

Balanced mesomorph: the second component is dominant and the first and third components are less and equal (or do not differ by more than one-half unit).

Ectomorphic mesomorph: the second component is dominant and the third component is greater than the first component.

Mesomorph-ectomorph: the second and third components are equal (or do not differ by more than one-half unit) and the first component is lower.

Mesomorphic-ectomorph: the third component is dominant and the second component is greater than the first component.

Balanced ectomorph: the third component is dominant and the first and second components are equal and lower (or do not differ by more than one-half unit).

Endomorphic ectomorph: the third component is dominant and the first component is greater than the second component.

Endomorph-ectomorph: the first and third components are equal (or do not differ by more than one-half unit) and the second component is lower.

Ectomorphic endomorph: the first component is dominant and the third component is greater than the second component.

Central: no component differs by more than one unit from the other two, and consists of ratings of 3 and 4.

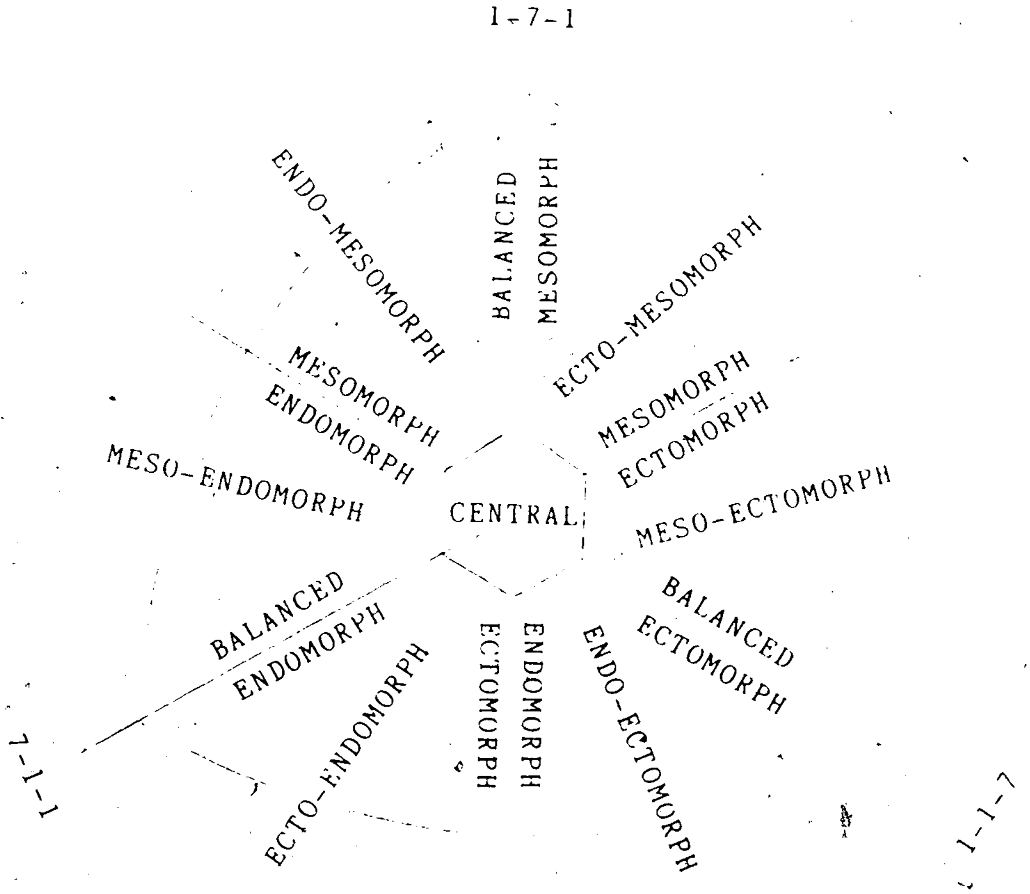


FIGURE 1. DESIGNATION OF SOMATOTYPE CATEGORIES

(Adapted from) CARTER, 1975

CHAPTER II

REVIEW OF LITERATURE

PHYSICAL ACTIVITY AND AGING

The physical decline associated with aging is not universal, uniform or inevitable (Edwards,1983). Physiological aging is a decline in ability to adapt to the environment (Smith and Gilligan,1983). Functional decline is a product of disuse as well as physiological aging. Changes due to age cannot be reversed, but changes due to chronic disuse can be (Smith and Gilligan,1983). Table 1 (Smith and Gilligan,1983) shows some of the changes which occur between the ages of thirty and seventy.. Smith and Gilligan (1983) believe that disuse accounts for about half of the functional decline.

Table 1 BIOLOGICAL FUNCTIONAL CHANGES BETWEEN THE AGES OF THIRTY AND SEVENTY

BIOLOGICAL FUNCTION	CHANGE (%)	
Work capacity	25-30	decrease
Cardiac output	30	decrease
Max. heart rate(beats/min)	24	decrease
Blood pressure (mm/Hg)		
Systolic	10-40	increase
Diastolic	5-10	increase
Respiration		
Vital capacity	40-50	decrease
Residual volume	30-50	increase
Basal metabolic rate	8-12	decrease
Musculature		
Muscle mass	25-30	decrease
Hand grip strength	25-30	decrease
Nerve conduction velocity	10-15	decrease
Flexibility	25-30	decrease
Bone		
Women	25-30	decrease
Men	15-20	decrease

Approximately twenty percent of the people in their sixties and seventies have a significantly higher physical capacity than the average for the age group and thirty percent are below average (Strauzenberg,1981). Relating exercise as the cause of these differences is difficult to do. Genetics, environment and lifestyle are all factors that affect aging (Borkan and Norris,1980). As of yet there is no proof that activity alters the rate of aging. There are, however, numerous studies that demonstrate that exercise is beneficial.

Heath et al.(1981) compared younger and older endurance athletes. The maximum heart rate and MVO2 were fifteen percent lower in the Master athletes than in the young athletes even though the training programs were equivalent. The lean body mass and the MVO2 of the Master athletes was sixty percent higher than a middle age sedentary group.

Men in their fifties who exercised vigorously on a regular basis have been found to have a MVO2 twenty to thirty percent higher than young sedentary men (Hollosky,1983) . The sedentary men in Dehn and Bruce's (1972) study experienced a threefold greater decline in VO2 than did the habitual running participants.

Borkan and Norris (1980) have found sportsmen to be biologically younger than their less active counter parts in lung function, plasma glucose and choice reaction time.

When they examined their subjects according to calories expended in activity per body weight the more active were biologically younger with regards to visual acuity, depth perception, grip strength and maximum work capacity.

Bone mineral density has been positively correlated with physical performance capacity and negatively with the prevalence of chronic diseases. Higher bone mineral density values have been found in men who participate in regular physical activity and nonsmokers than in sedentary men or smokers (Suaminen et al.,1984). Sidney et al. (1977) examined a group of septuagenarians over a year of an endurance training program. Bone calcium loss did not occur except in the group taking the least amount of exercise.

The importance of the starting age of physical activity is still uncertain. It appears that a certain amount of training in youth results in larger increases in the respiratory and circulatory parameters than a corresponding amount of training later in life. Even years after a strenuous exercise program in youth the larger dimensions for heart,lungs and blood volume are retained (Grimby and Saltin,1971). Grimby and Saltin (1971) believe that the respiratory and circulatory systems dimensions are primarily genetically influenced, but training in youth is important for their development. They state that training in the twenties and thirties may still influence the systems dimensions but that training in older adults primarily results in improved utilization of the existing parameters. Thus continued training is necessary for functional capacity maintainance.

The findings of deVries (1970) offer hope for those adults who were not active during their youth. He found that the people who made the most gains in an adult exercise program were the ones who were the least active prior to it. In his study, no relationship was observed between life history activity and physical fitness at the time of entry into the program. The lack of correlation could have been due to the fact that none of the participants were active at the time of the program. DeVries concluded that vigorous training in youth is not necessary for improvement in physical work capacity in the adult years.

Gain in performance from training is determined by comparing what one can do when untrained and the maximum achieved after adequate training. As one becomes older the maximum one can acheive declines progressively. The improvement margin decreases (Brouha,1961).

A study by Parizkova and Eiselt (1966) examined the effects of exercise on anthropometric measures in old age. Exercise in the fifty-five to sixty-five age group had no effect on the relative weight (ratio between height and weight) of the men, however, their abdominal circumferences decreased and their lean body mass increased along with their thigh and forearm circumferences. Exercise had no apparent effect on those above sixty-five.

White and Young (1978) examined the effects of a twelve week exercise program using two groups of fifteen women; age twenty-one to thiry-two, and thirty-four to fifty-seven. The exercise was undertaken three times a week with each session lasting forty-five minutes. There were no significant cardiorespiratory or body composition differences between the two groups at the start of the program. At the end, both groups had decreased their submaximal heart rate and the older age group also reduced their resting heart rate, decreased their percent body fat and increased their body density.

Tzankoff et al. (1972) looked at the effects of six months of exercise using young and old inactive men. Both groups had a decrease in expiratory volume, blood lactate and heart rate at submaximal work and an increase in maximal work capacity at exhausting work loads. The old men exhibited greater percentages of increase in the fitness parameters than the young men but they had lower initial maximal work capacities.

Atomi and Miyashita (1976) studied the effects of a recreational program on the aerobic capacity of adults. The MVO2 of the new members increased with two years of participation. There was, however, a limit to the level that the activity could affect the aerobic work capacity. There was no difference between the MVO2 of the two and four year members.

A study by Carter and Phillips (1969) also investigated the work capacity plateau. They found that the adults (age thirty-nine to fifty-nine) in their exercise program reduced their weight, percent fat, skinfolds and girths as well as increased their specific gravity. This change occurred during the first year of the program and was maintained throughout the second year. The age matched control group increased in weight, girths and endomorphy during this time period.

It seems apparent that the benefits of training in youth are slowly lost if physical activity ceases. Middle-aged and Master athletes training for middle and long distance events have a MVO2 fifty percent or higher than that of ex-athletes who stopped training some years ago (Hollosky,1983). The MVO2 in healthy sedentary man declines approximately nine percent per decade after the age of twenty five. Exercise cannot prevent the decline from occurring but it can raise the initial MVO2 level and possibly slow the decline. The decline in some Master athletes is five percent per decade (Heath et al,1981).

Physical training is often associated with body composition changes (Wilmore,1983a). Exercise is promoted on the belief that it will increase lean body mass and decrease body fat and total body weight. This, however, has not been proven to be universally true. As exercise is a general term, its frequency, intensity and duration varies in studies and the effects of exercise on body composition are not conclusive (Pollock et al.,1975). According to the table in Wilmore's (1983a,b) review, the average loss in relative body fat from fifty-five studies was only 1.6%. The studies had programs which ranged from six to one hundred and four weeks.

MASTERS SWIMMERS

Few studies have examined the effects of Masters swimming on adult fitness levels. Rahe and Arthur (1974) used a cross-sectional design to examine the swim performance decrease in males between the ages of twenty-five and fifty-nine. They discovered that the decline during this span was approximately one percent per year. Butterfly showed the largest decline and front crawl the least (Rahe and Arthur,1975). Rahe and Arthur (1974) also examined maximum pulmonary ventilation, maximum oxygen consumption and muscle strength. From the age of twenty-five to fifty-nine the decline was twenty-five, thirty, and twelve percent respectively.

Hartley and Hartley (1984) have recently published a paper on performance changes in Masters swimmers. Upon longitudinal examination, performance declined over a five year period with increasing cohort age. The cohort difference was larger than the age changes. A cross-sectional examination on the best performers at the two times of measurement reduced the age changes within the cohorts. The authors explain the cohort difference as being due to varying exposure to innovations in training and varying training commitment levels . The shorter events were more affected by the aging than the longer events. The young swimmers showed a much greater drop in speed (yd/sec) from the 50 to the 1650 yard events than did the older swimmers. The Hartleys conclude that adults must expect performance decline with advancing age but the decline can be much smaller than that found from cross-sectional comparisons of cohorts.

Rahe and Carter (1976) examined the background and body structure of middle-aged male competitive swimmers. They examined forty-two subjects between the ages of forty and fifty-nine. These Masters were homogeneous in terms of ethnic, educational and occupational backgrounds. Three-quarters of them had learned to swim by the age of nine; thirty-five out of forty had swum in a youth program and half of them had been champions at a local level. In body composition analysis it was discovered that the

Masters champions were lighter, less endomorphic and more ectomorphic than the nonchampions. This study also compared the body structure composition of the Masters to the somatotype data from Cureton's study on the United States 1948 Olympic swim team. The subjects in Rahe and Carter's study are cohorts to Cureton's subjects as they are of comparable age. It was found that the somatotype characterics of champion swimmers of this age group who maintained their swim training level had not changed significantly over the last twenty-five years. The Masters swim champions, however, are more endomorphic than Carter's modern day college swim champions. The difference appearing in the trend study and not in the cohort study is probably a reflection of the changing swim training techniques. Masters swim workouts resemble the age group workouts of the past. The workouts of the present day young swim champions demand a greater time commitment.

Vaccaro et al. (1984) investigated body composition and physiological responses of female Masters swimmers. They divided eighty-seven female swimmers into two groups (highly trained and not highly trained) on the basis of the intensity, frequency and duration of the swim workouts. Within each age group the highly trained were lighter in weight, had less percent body fat and heavier in body density. For both groups the general trend with increasing age was decreased height, lean body weight, and body density. Weight and percent body fat increased. The highly trained swimmers had lower heart rates at rest and during each of the first three stages of work than the less highly trained women. No age-related statistical differences across age groups for heart rate or blood pressure were found in the highly trained group. The mean rate of decrease in MVO2(ml.kg-1.min-1) for the highly trained and the not highly trained was seven and eight percent respectively. The training status did not seem to have much effect on the rate of VO2 decline.

MALE AND FEMALE DIFFERENCES

Physical and physiological differences between the sexes are well documented. Physically, females are usually shorter in height, have a greater percentage body fat and a smaller proportion of muscle in relation to body mass than males. In full maturity, the average female is five inches shorter and ten percent fatter than the average male. With regards to somatotype, the female is more endomorphic and less mesomorphic than the male (Wells, 1985).

The body composition differences are partly responsible for the aerobic power differences between the sexes. Men typically have absolute VO2 max. values 40 to 60% greater then womem. When this is express in terms of body weight the sex difference is reduced to 20 to 30%: This difference can even be further reduced to 15% if the VO2 max is expressed relative to fat-free weight (Wells,1985).

The difference between aerobic power have also been found to be less between trained men and women than between untrained men and women. Cureton suggests that there is only a 5% difference due to the inherent biological differences between the sexes (Drinkwater,1984).

SUMMARY OF REVIEW OF LITERATURE

A decline in physical functions is associated with chronological aging. Decreases in maximum heart rate, cardiac output, vital capacity and lean body mass results in a lower basal metabolic rate and a lower work capacity. The degree of functional change varies between individuals. Physical activity has been suggested as a method of keeping functional decline to the minimum. Active older people have been found to be biologically younger with regards to lung function, bone density, lean body mass and maximum work capacity than their sedentary counterparts.

The benefits obtained from a training program are related to the frequency, duration and intensity of the program as well as to the improvement margin that exists within the individual. The more highly trained tend to have a higher level of cardiovascular fitness and less body fat than the less highly trained.

Master Swimming champions are lighter, less endomorphic and more ectomophic than non-champions. The Masters champions however are more endomorphic than todays college age swim champions.

Swim performance suffers from an age related decline. This decline is greatest in the butterfly stroke and the least in the front crawl.

The average female is shorter in height, has more percent body fat and less proportion of muscle than the average male. VO2 max is typically higher for males than females.

CHAPTER III

METHODS and PROCEDURES

SUBJECTS

Twenty females and forty males of the Edmonton Masters Swim Club volunteered for this study. This represented almost the whole club that was training in June 1985. The age of the sample members ranged from twenty to seventy-one years.

Nine of the females and eighteen of the males had swum competitively prior to joining the Masters. All of the females with the competitive swimming background were in the 20-29 age category. The distribution of males who had competed in swimming before Masters was broader. Nine were in the 20-29 category, four were in both the 30-39 and 40-49 category and one was in the above 50 category.

PROCEDURE

The testing took place in June at the University of Alberta. June was the last month that the club held organized practices until September. The subjects came in for the testing at their convenience. They were not tested unless they were feeling healthy. All volunteers signed a consent form.

Body composition was assessed by hydrostatic weighing and somatotype by the Heath Carter method. Cardiovascular fitness was measured on a treadmill using a modified

Balke-Ware protocol. Information regarding involvement in sports was obtained by questionnaire. The performance data were obtained by the two Masters swim coaches ranking the subjects on a scale of one to nine, with nine representing the most advanced swimmer.

HYDROSTATIC WEIGHING

Each subject was weighed on land in a bathing suit on a Detecto scale to the nearest 0.1 kilogram. The subject then climbed into a 10 x 4 x 6 foot concrete tank and sat on an aluminum chair in the center of the tank. A 20-pound weight belt was placed across the lap. The chair was attached to a strain gauge that was suspended from the ceiling. A Sargent Recorder amplified and recorded the forces acting upon the strain gauge.

The water temperature was recorded prior to each weighing. It ranged from 31 to 36 degrees celsius. The water level varied from being shoulder to chin height on the seated subject. Upon sitting in the chair the subject leaned forward until totally submerged and removed the air bubbles from the skin and hair.

Subjects were hydrostatically weighed at total lung capacity. They were instructed to inspire maximally, pinch their nose closed with one hand, hold on to the arm of the chair with the other hand, and to slowly lean forward until totally submerged. Underwater weight was obtained in approximately five seconds.

Five trials were taken. The average of the trials was recorded as the underwater weight.

Once the underwater weight was obtained, the vital capacity was measured using a Collins Vitalometer. The subject was seated in the water with the water at shoulder to chin height. Two readings were taken unless they differed, in which case a third reading was taken. The score was recorded as the average of the two readings. Residual volume was estimated from the vital capacity.

HEATH-CARTER SOMATOTYPING

The somatotype rating was obtained using anthropometric data alone. The equipment consisted of a Lange skinfold caliper, a steel flexible tape, decto weigh scales, a height scale, a right angle, and a wooden sliding caliper.

Standing Height (Carter,1975)

The subject stood with feet together. Heels, buttocks, upper back, and rear of head all contacted the wall scale. The eyes looked straight ahead. A right angle was placed gently at the highest point. The measurement was recorded to the nearest 0.1 centimeter.

Skinfold Techique (Carter,1975)

A double layer of skin and subcutaneous tissue was grasped by the thumb and forefinger. Full spring pressure was applied to the skinfold and the reading taken. The reading was taken before the fat moved out of the fold. The Measurement was recorded to the nearest 0.1 millimeter.

Skinfold Sites (Carter,1975)

All of the sites were marked prior to the measurements. The measurements were taken in the order of skinfolds, diameters, and girths. The order was repeated so that at least two measurements were obtained for each site. If the two readings differed, a third reading was taken and the average of the two closest readings was accepted as the measure.

Triceps

The subject stood with the right arm by the side. The elbow was extended and relaxed. The skinfold was taken over the triceps muscle on the back of the right arm. The fold was parallel to the long axis of the arm.

Subscapular

The subject stood upright with arms by the sides. The skin fold was taken lateral to the inferior angle of the right scapula. The fold ran downward and outward in the direction of the ribs.

Suprailiac

The subject stood erect, drew a medium-sized breath and held it. The fold was raised one to two inches above the right anterior superior iliac spine. The fold ran forward and slighly downwards.

Calf

The subject stood with one leg placed on a bench so that a right angle was formed at the knee. The fold was taken on the medial side of the right calf just above the level of the maximum girth. The fold ran vertically.

Bone Diameters (Carter,1975)

The two end points of the sliding wooden calipers were placed on the epicondyles of the distal extremities of the humerus or the femur most lateral to the medial plane of the bone so that they bisected the angle of the joint and lay in the same plane as the limb. The measurement was recorded to the nearest 0.1 centimeter. The right side was measured unless it had at one time received an injury. In that case the non-injured side was measured.

Humerus

The subject raised the arm so it was level with the shoulder. The forearm was flexed at a right angle and the measurement taken.

Femur

The subject stood with the right foot on a bench. The knee was at a right angle and the measurement taken.

Muscle Girths (Cater,1975)

The tape was placed around the limb and moved, at right angles to the long axis of the bone, until the largest reading was obtained. The tape was always in contact with the skin but did not cause any indentation. The measurement was taken on the right side of the body and recorded to the nearest 0.1 centimeter.

Biceps

The subject held the right arm horizontal in front of the body. The forearm was supinated and flexed at a right angle.

Calf

The subject stood with feet shoulder width apart. Weight was distributed equally between the feet.

TREADMILL

Cardiovascular fitness was measured on a treadmill using a modified Balke-Ware (1959) protocol. The subjects walked on a level, motor-driven treadmill at three miles per hour for three minutes; thereafter the treadmill was raised a three percent grade at the end of each succeeding three-minute interval. The test ended when the subject reached Karonen's (1957) proposed exercise heart rate.

$$\mathrm{HRex} = \mathrm{HRrest} + 0.60(\mathrm{HRmax} - \mathrm{HRrest})$$

The maximum heart rate was calculated by the formula (Jones et al., 1975):

$$HRmax = 210 - (age \times 0.65)$$

The heart rate after five minutes of lying down was taken as the resting heart rate. This was obtained just prior to the cardiovascular test.

Heart rate was monitored on a Quinton Heartrate Monitor (model 650). The time in minutes and seconds required to reach the desired heart rate was recorded as the subject's score.

PERFORMANCE RATING

The two Masters swim coaches jointly rated all of the subjects in relation to their swimming ability over the four competitive strokes. The rating was primarily based on speed and ability. All of the subjects were rated against the same standard.

PERORMANCE LEVEL

9....Fast in all the strokes.

8....Competent in all the but excels in no more than three of them.

7....Competent in all four of the strokes.

6....Swims only three of the strokes but is fast.

5....Swims only three of the strokes and travels at a constant speed.

4....Still developing the technique of the three strokes.

3....Rests every eight lengths.

2....Rests every four lengths.

1....Stops at the ends.

SPORTS INVOLVEMENT

The sports involvement questionnaire was handed out when the subjects were first tested. At this time, a full explanation was given on the type of information that was required. The subjects were allowed to finish the section on past sports involvement at their convenience.

In order that sports involvement could be used as a comparable variable, the information had to be placed into numerical terms. To obtain a Masters swim involvement score, the person's years of membership was multiplied by the average number of practices attended weekly and by their average duration.

The total current sports involvement score for each sport was obtained by multiplying the average weekly frequency with the average duration. The score obtained from each sport was then totaled to give the final value.

The calculation of past sports involvement used a rating system. One point was given if the sport participated in was seasonal and three points were given if the sport was a year-round activity. A point was given for every year the person was active in the sport. If the sport involved under three hours of weekly commitment, then one point was given. Two points were given if the sport involved three to six hours a week, and three points if more than six hours a week.

The score was calculated by multiplying the points from whether or not the sport was seasonal by the points from the duration of participation and the points from the intensity. The score from all the sports was then summed. The final score was obtained by dividing the grand sum by the person's age.

CALCULATIONS FOR BODY DENSITY DETERMINATIONS

The determination of body density via hydrostatic weighing is based on Archimedes' principle that a body immersed in a fluid is acted on by a buoyant force, which is made evident by a loss of weight equal to the weight of the displaced fluid. Thus body density is calculated by the formula:

$$Db = (Ma \times Dw)/(Ma - Mw)$$

Db is the density of the body
Ma is the weight of the body on land
Mw is the weight of the body in water
Dw is the density of the water

This formula when corrected for vital capacity, residual volume and gastro-intestinal gases becomes (Ross, Marrfell -Jones):

$$Db = Mw/((Ma - Mw/Dw) + RV + VC + GIgas)$$

RV is residual volume

VC is vital capacity

GI gas is the volume in the gastro-intestinal tract

The residual volume was estimated to be twenty-five and thirty percent of the vital capacity in cubic inches for females and males respectively . A constant of 7.01 cubic inches was assumed for the volume in the gastro-intestinal track (Macnab and Quinney, 1975).

The weight in the water was calculated by the formula:

((belt wt. x chart reading)/ recorder range) - belt wt.

BODY FAT

The formula of Brozek et al. (1963) was used to estimate percent body fat from body density.

% body fat = ((4.570/body density) - 4.142) x 100

FORMULAE FOR THE CALCULATION OF SOMATOTYPE (Drinkwater, 1984)

Endomorphy rating

-0.7182 + 0.1451(X) - 0.00068(X)(X) + 0.0000014(X)(X)(X)

X = sum of triceps, subscapular and suprailiac skinfolds.

For height corrected endomorphy X is multiplied by 170.18 / height in cm.

Mesomorphy rating

(0.858 humerus width + 0.601 femur width + 0.188 arm girth + 0.161 calf girth) - (height x 0.131) + 4.5

Girths should be corrected for fat by subtraction of the appropriate skinfold.

Ectomorphy rating

(HWR x 0.732) - 28.58

HWR = Height divided by cube root of weight.

If a negative value of ectomorphy is obtained the rating of 0.5 is ascribed.

X,Y coordinates

For plotting on a somatochart.

X = ectomorphy - endomorphy

Y = 2(mesomorphy) - (endomorphy + ectomorphy)

STATISTICAL METHODOLOGY

All of the results were correlated using the Pearson product-moment technique and placed into a matrix. Mean, standard deviation, and range of the variables provided age, gender profiles. Frequency distribution of the means were graphically displayed.

CHAPTER IV

RESULTS AND DISCUSSION

SUBJECT DISTRIBUTION

The subject distribution with regards to sex and age is graphically displayed in Figure 2. The males outnumbered the females 2 to 1. The majority of the female subjects were in the 20 to 29 age category. The males almost had equal representation in the 20 to 29 and the 30 to 39 age category. All the subjects but one were fully tested. A 24 year old male did not take the treadmill test because of time commitments.

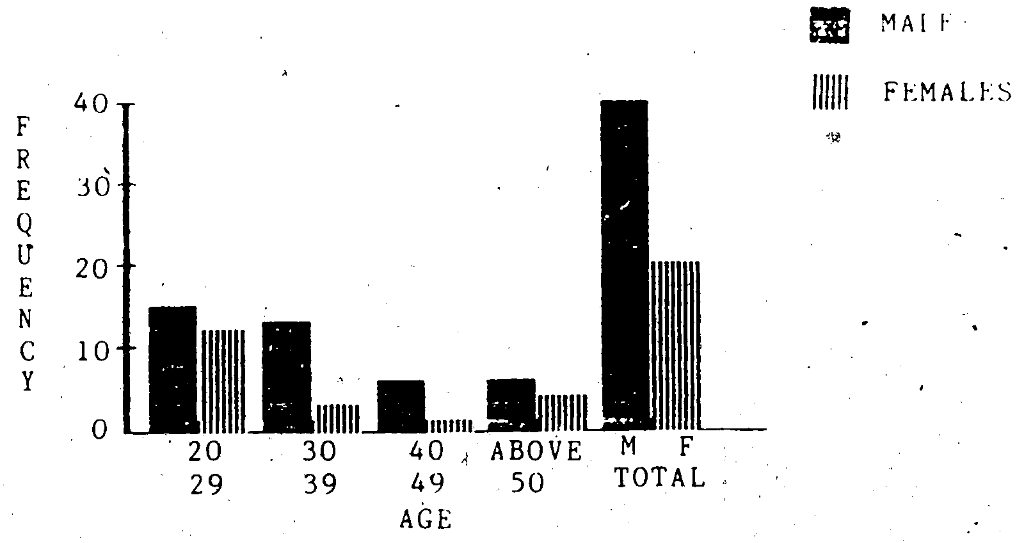


FIGURE 2. FREQUENCY DISTRIBUTION OF SAMPLE

BODY FAT

The mean, standard deviation and range of the Masters swimmer's percent body fat are shown in Table 2 according to age group and sex. Figure 3 graphically deplicts the means.

TABLE 2. Mean, Standard Deviation and Range of Masters Swimmers Percent Body Fat

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	14.05	4.00	6.80 - 18.90
(F) N=12	21.38	6.35	11.40 - 30.70
Age 30-39			
(M) N=13	17.52	5.57	10.70 - 26.10
(F) N=3	25.17	8.29	15.60 - 30.70
Age 40-49			
(M) N=6	20.25	5.76	12.50 - 27.60
(F) N=1	37.80		
Above 50			
(M) N=6	27.17	6.81	18.40 - 36.90
(F) N=4	38.15	12.53	24.50 - 49.80
Total			
(M) N=40	18.08	6.71	6.80 - 36.90
(F) N=20	26.13	10.31	11.40 - 49.80

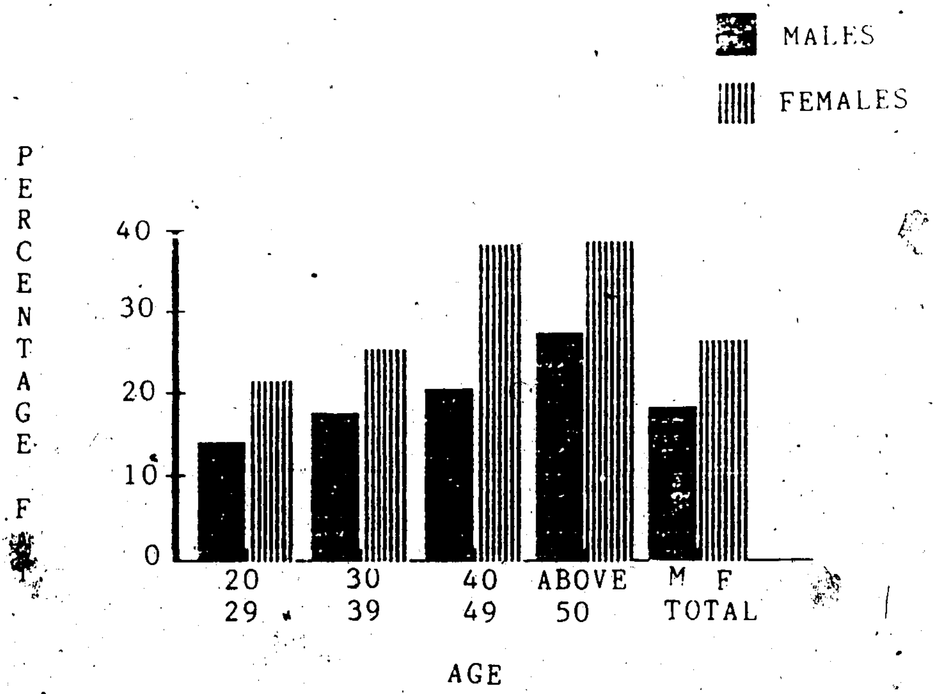


FIGURE 3. FAT PERCENTAGE OF MASTERS SWIMMERS

The trend among both sexes was for body fat to increase with age. Interestingly, the percentage fat difference was almost identical between the sexes for the 20 to 29 and the 30 to 39 age group. The older age groups were composed of too few people for comparisons to be made.

In this study, the fat percentage was estimated from the density obtained via hydrostatic weighing, not skinfolds. This technique is based on a few assumptions such as: the densities of the fat and lean components are known; the densities of these components are constant between individuals; the proportion of the lean component is constant within and among individiuals; and individuals differ only in amount of stored fat. Work on cadavers has shown that both the lean component densities and their proportions vary between individuals (Wimore,1983b).

The fat percentage in the females over the age of forty seemed suspiciously high. Variations in bone mineral and total body water causes over estimation of relative body fat in both the young and the older population (Wilmore,1983b). A common variation in bone density is osteoporosis (porous bones), a condition which is more commonly found in older women than older men (Vallbona and Baker,1984). Osteoporosis results when the rate of cortical bone deposition on the outer surface of the bone is less than the rate of cortical bone loss from the endosteal surface (Montoye,1984).

The estimation of residual volume from vital capacity can also cause an over-estimation of relative body fat, especially in the older population or among individuals with a lung ailment. As an accurate measurement of residual volume was not possible, it was assumed that residual volume was 30% of vital capacity for males and 25% for females. This ratio was kept constant for all age groups. With age, however, residual volume tends to increase and vital capacity tends to decrease (Table 1). Even though exercise has been shown to slow down demineralization of bone (Sidney et al.,1977), the high estimated fat values for the females over forty could be due to a combination of bone density overestimation and residual volume under-estimation.

Comparisons of the mean of each age group to the Canadian norms for percentage body fat (obtained from skin folds), indicated that the men were just above the 80th percentile. The women were in the 50th and 20th percentile for the 20 to 29 and 30 to 39 age group respectively (Canada Fitness Survey,1981).

The mean fat values for the females corresponded to the age matched values of the "not highly trained" females in Vaccaro's et al. study (1984). The "highly trained swimmers" had considerably less fat. Vaccaro et al. (1984) defined "highly trained" as swimming at least three times a week for an hour. The not "highly trained" swam a minimum of one half hour twice a week and covered at least 455 meters. The majority of females in this study would have been classified as "highly trained".

The University of Alberta's swim team was hydrostatically weighed at the start of their 1985-86 season (unpublished data). The mean fat percentage of the thirteen male swimmers was 11.1. Their mean age was 20.2. The mean fat percentage of the fifteen female swimmers was 21.7 and their mean age was 20.8. The percent fat values from the youngest age group of Masters swimmer females matched well with the female University swimmers while the male Masters swimmers appeared to be slighty higher fat percentage than their University counterparts.

SWIMMING LEVEL

The mean, standard deviation, and range of the assessed swimming level are shown in Table 3. Figure 4 displays the means only. The swimming level appeared to decrease with age for the women. The men followed the same pattern except for the 40 to 49 age group. This decline is due to the rating system. All of the subjects were rated against the same standard, therefore, the younger males were favoured for the highest ratings. The females or older Masters who obtained the highest ratings would be outstanding in their own category.

As swimming level was judged both on technical skill and speed, the finding of Rahe and Arthur (1974) that the decline in swimming speed is approximately 1% per year after the age of thirty can explain the decreasing trend. Technically, butterfly was the stroke which decided whether a person rated above a 7. Butterfly was taught and swum during the Master swimming practices, yet the older age group competitive swimmers were more efficient at this stroke. Rahe and Arthur (1975) found the decline in the butterfly speed to be approximately 1.5% for men and 1.8% for women per year after the age of thirty.

TABLE 3. Mean, Standard Deviation, and Range of the Assessed Swimming Level

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	7.60	1.88	3.00 - 9.00
(F) N=12	7.08	1.37	5.00 - 9.00
Age 30-39			
(M) N=13	6.69	1.74	4.00 - 9.00
(F) N=3	5.33	1.14	4.00 - 6.00
Age 40-49			
(M) N=6	7.66	0.50	7.00 - 8.00
(F) N=1	5.00		
Above 50			
(M) N=6	3.50	2.43	1.00 - 7.00
(F) N=4	4.50	2.37	2.00 - 7.00
Total			
(M) N=40	6.70	2.22	1.00 - 9.00
(F) N=20	6.20	1.84	1.00 - 9.00
N=60	6.53	2.10	1.00 - 9.00

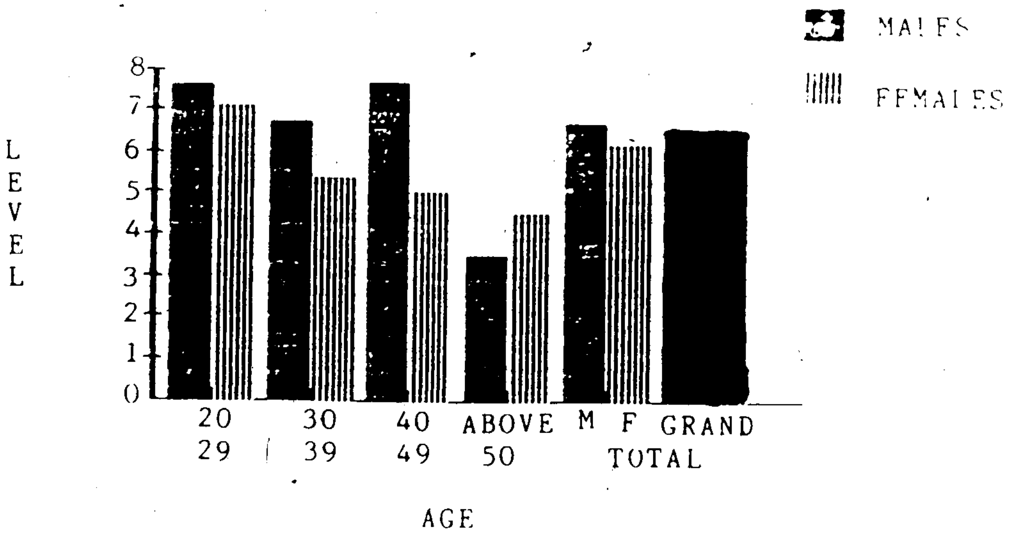


FIGURE 4. ASSESSED SWIMMING LEVEL

CARDIOVASCULAR FITNESS

Over the years a variety of stress tests have been developed to measure cardiovascular fitness. The Balke-Ware treadmill procedure was chosen as the most suitable for this study for a number of reasons.

Walking is an activity utilized in day-to-day living. The differences in walking efficiency are small between individuals (Balke-Ware,1959). Skill would not be a major factor limiting the outcome as it would have been if a swimming test was utilized. Walking involves the entire body. Cycling tends to utilize primarily the lower body, and local fatique could cause the test to end prematurely.

In the Balke-Ware test the treadmill moves at 3.0 m.p.h. throughout the test. This speed provides a warmup without tiring the subjects. Changing the incline for increased power output meant that the whole test was performed at a walking gait. Many of the subjects would have been too anxious running on the treadmill. A submaximal test protocol was necessary because of the wide range in the subjects' ages.

The Balke-Ware test does not require the calculation of an oxygen uptake value (Balke-Ware,1959). The time required to reach a predetermined heart rate was used as the fitness measure. Because the subjects for this study ranged widely in age, it was necessary to individualize the heart rate limits at which the test was to be stopped. Maximum heart rate declines with age (Londeree and Moeschberger,1982). In order to compare individuals they had to accomplish similar work loads. At the same work load the more fit individual will have a lower heart rate and a more rapid post-exercise heart rate recovery, but the maximum heart rate will not be affected (Smith and Kampine, 1984).

Karvonen's method of computing the 60% training heart rate level was used as it takes into account the subjects potential heart rate increase. Davis and Convertino (1975) compared two other methods of predicting training intensity to Karvonen's method and found Karvonen's method to be superior.

The results of the treadmill test are displayed in

Table 4 and Figure 5. There was a distinct decline in the time spent on the treadmill with increasing age. Interestingly, the standard deviations remain almost the same. The females were approximately three minutes slower than the males. The largest difference between the sexes was found in the youngest age group.

The results follow closely to that which is documented. Maximum aerobic power decreases with age. The decline in MVO2 occurs regardless of level of activity and the rate of decline is slighty less in women (Raven and Smith,1984). This decline can be partly explained by accepting that the age related loss of lean body mass infers a decrease in the active metabolic tissue (Ravin and Smith,1984). Astrand and Rodahl(1977) state that no significant differences in maximal aerobic power exist between the sexes up until puberty. After puberty, women's aerobic power is typically 70 to 75 that of men's. Females have a smaller stroke volume and a higher heart rate for a given severity of exercise (Astrand and Rodahl,1977). In the age group 20 to 29 years in this study, the female's mean time on the treadmill was 70 percent of the male's time.

TABLE 4. Mean, Standard Deviation and Range of the Time on the Treadmill

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=14	16.94	2.76	13.00 - 22.30
(F) N=12	11.70	3.03	7.20 - 18.50
Age 30-39			
(M) N=13	15.38	3.35	11.00 - 22.00
(F) N=3	12.33	3.03	10.10 - 15.80
Age 40-49			
(M) N=6	13.97	3.57	7.50 - 18.00
(F) N=1	12.50		
Above 50			
(M) N=6	9.90	3.17	4.20 - 14.80
(F) N=4	9.73	5.02	4.40 - 14.50
Total			
(M) N=39	14.88	3.92	4.20 - 22.30
(F) N=20	11.44	3.24	4.40 - 18.50
N=59	13.71	4.00	4.20 - 22.30

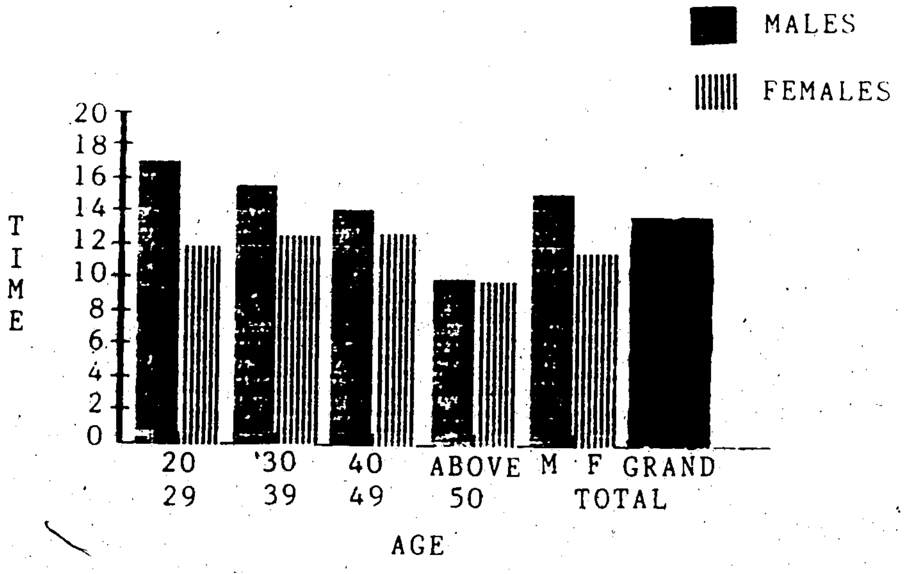


FIGURE 5. TIME ON TREADMILL

RESTING HEART RATES

The resting heart rates used in this study were not true resting rates but rather pre-exercise heart rates. Resting heart rate does not change with age (Bortz,1982), rather resting bradycardia is a consequence of physical conditioning (Raven and Smith,1984). A study by Sime et al.(1972) demonstrated that heart rate (resting and exercise) is a highly stable characteristic over a period of time.

Table 5 and Figure 6 show the Masters swimmers' resting heart rates. The above 50 year old age group males had the highest mean resting heart rate values. The 20 to 29 year old females had the greatest range of resting heart rate values. The female with the resting heart rate of 36 was, at the time of the testing, running over sixty miles a week.

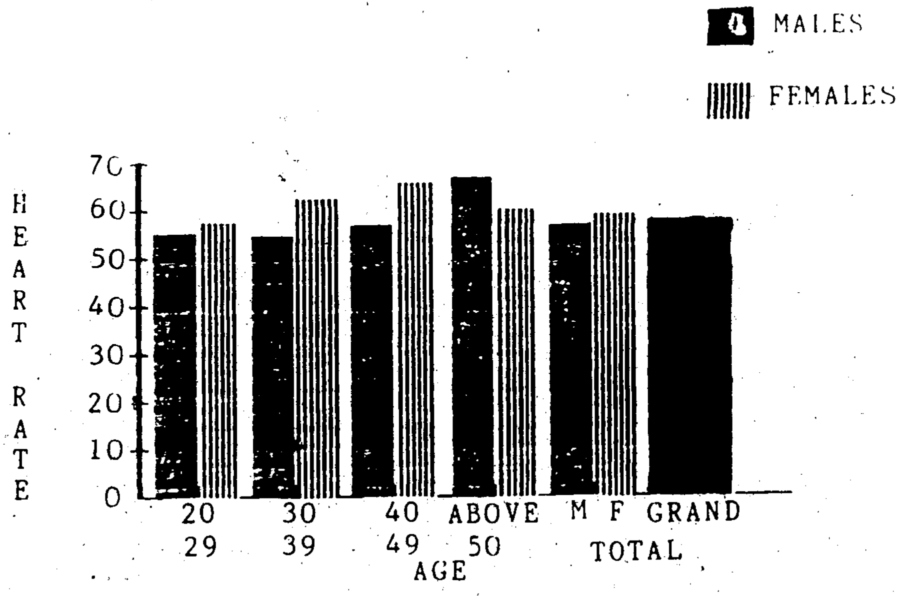


FIGURE 6. RESTING HEART RATES

Table 5. Mean, Standard Deviation, and Range of the Resting Heart Rate

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=14	55.29	8.53	42.00 - 72.00
(F) N=12	57.25	9.67	36.00 - 72.00
Age 30-39			
(M) N=13	54.38	8.76	45.00 - 78.00
(F) N=3	62.66	7.56	54.00 - 68.00
Age 40-49			
(M) N=6	57.00	5.02	54.00 - 66.00
(F) N=1	66.00		
Above 50			
(M) N=6	67.17	9.06	54.00 - 79.00
(F) N=4	60.00	8.47	48.00 - 66.00
Total			
(M) N=39	57.08	9.12	42.00 - 79.00
(F) N=20	59.05	8.88	36.00 - 72.00
N=59	57.74	9.00	36.00 - 79.00

SPORTS INVOLVEMENT

In this study, sports involvement refered only to the amount of time dedicated to physical activity. Intensity was not taken into account. The data were based on recalled information and thus subject to human error. The older subjects had a lot of years to recall. In any case, examination of the sports involvement values made analysis of activity trends possible.

The level of Masters swimming involvement (Table 6 and Figure 7) was calculated by the formula :

No. of years a member X No. of practices attended weekly X average duration of practices

The trend of the older subjects to appear more involved in the club was partly due to the number of years in which they had been members (one must be over twenty to join). Values of 1.5 or lower represented new members. The two male groups, age 40 to 49 and the above age 50 are areas where new members have not joined. The value of 38.3 represented the highest obtainable value. The club still had two of its original members and they generally came to all practices and stayed for the entire duration.

It appeared from these results that Masters swimming was more attractive to males. The males outnumbered the females by a two to one ratio and they were slightly more involved.

Table 6. Mean, Standard Deviation, and Range of Involvement in Masters Swimming

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	7.51	6.10	0.50 - 22.50
(F) N=12	6.43	5.90	1.50 - 20.00
Age 30-39			
(M) N=13	7.74	5.33	1.50 - 21.00
(F) N=3	5.73	4.41	1.20 - 10.00
Age 40-49			
(M) N=6	13.22	10.05	2.30 - 27.00
(F) N=1	15.00		
Above 50			
(M) N=6	13.60	15.76	4.50 - 38.30
(F) N=4	11.20	18.15	1.00 - 38.30
Total			
(M) N=40	9.36	7.95	0.50 - 38.30
(F) N=20	7.95	9.12	1.00 - 38.30
N=60	8.72	8.24	0.50 - 38.30

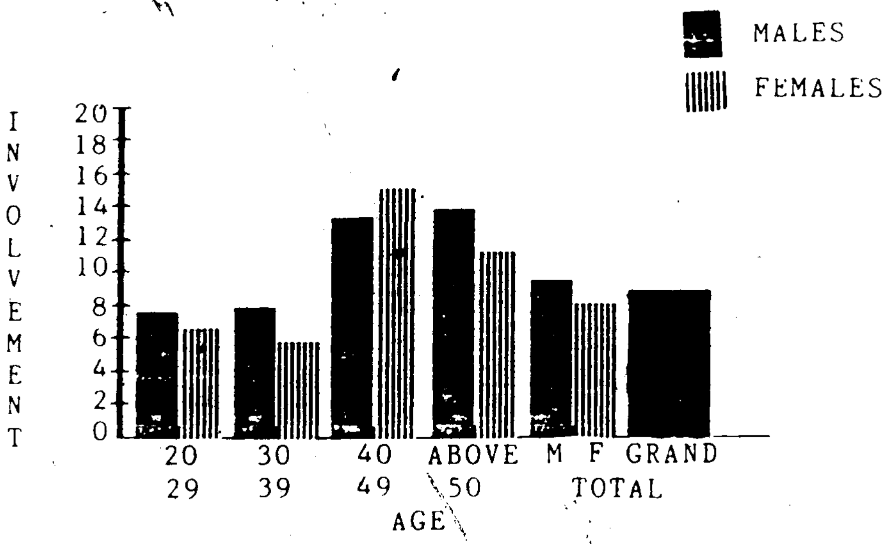


FIGURE 7. MASTERS SWIM INVOLVEMENT

The present sports involvement only included the total weekly amount of sports activity that the subjects were participating in at the time of the testing (Table 7 and Figure 8). Looking at the totals, it appeared that there was no sex difference between the present amount of sports participation. This must mean that the females were more active in sports outside of Masters swimming.

It is also interesting to note that the sports involvement does not fluctuate much over the different age groups with the one exception of age 30 to 39 females. The drop of involvement for this group could be due to the small sample size.

Table 7. Mean, Standard Deviation, and Range of Present Sports Involvement

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	8.71	7.08	1.80 - 30.00
(F) N=12	10.09	5.11	5.50 - 21.80
Age 30-39			
(M) N=13	10.42	7.45	1.00 - 26.30
(F) N=3	6.00	1.74	5.00 - 8.00
Age 40-49			
(M) N=6	8.28	6.25	3.00 - 19.00
(F) N=1	8.50		
Above 50			
(M) N=6	9.57	5.20	3.50 - 16.00
(F) N=4	11.45	10.89	2.00 - 26.80
Total			
(M) N=40	9.33	6.65	1.00 - 30.00
(F) N=20	9.67	6.10	2.00 - 26.80
N=60	9.44	6.45	1.00 - 30.00

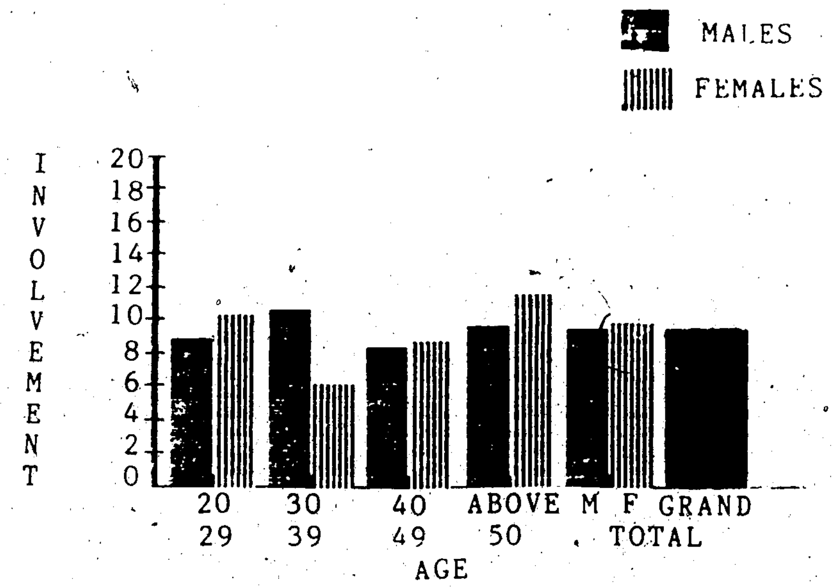


FIGURE 8. PRESENT SPORTS INVOLVEMENT

Sports involvement over the last two years (Table 8 and Figure 9) was examined to separate established activities from newly acquired activities. Atomi and Miyashita (1976) found that the positive gains from participating in an activity start to plateau between the first and second year of involvement.

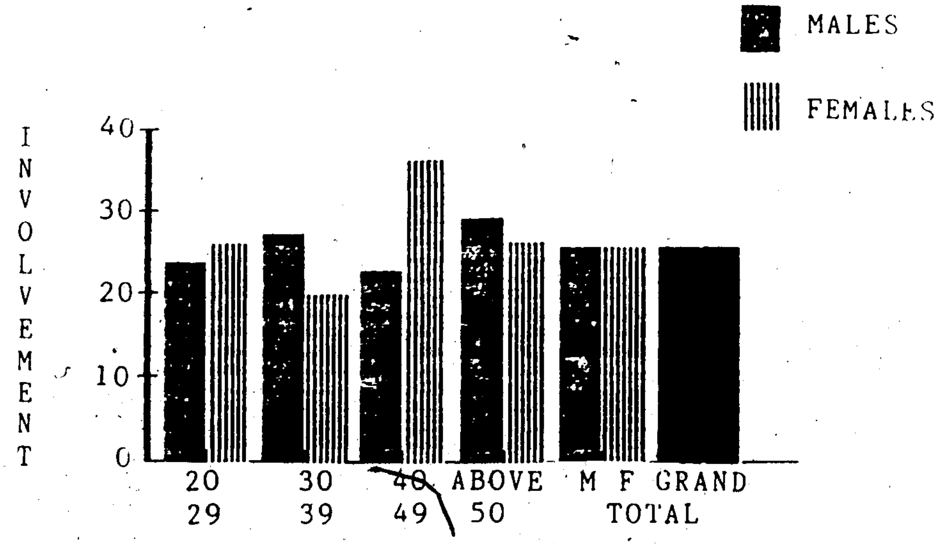
In this study, it appeared that the most active groups were the oldest ones. The finding from the 1981 Canada Fitness Survey is that, "A perceived lack of time due to work pressures is the most important obstacle keeping people from being more active." Therefore it would appear that the retired subjects are elevating the mean activity level up in the two older age groups.

This high activity level among the older groups was unique. In the Canada fitness survey the older Canadians were more sedentary than younger ones. Spare time was filled with activities other than sports participation.

Young males and females were found to be equally active in the fitness survey.

Table 8. Mean, Standard Deviation, and Range of the Level of Sports Involvement during the Last Two Years

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	23.60	10,69	6.00 -- 52.00
(F) N=12	25.83	12.32	9.00 - 43.00
Age 30-39			
(M) N=13	27.12	14.44	9.50 - 56.00
(F) N=3	19.83	2.25	17.50 - 22.00
Age 40-49			
(M) N=6	22.66	12.04	8.00 - 42.00
(F) N=1	36.00		
Above 50			
(M) N=6	28.83	13.69	14.00 - 51.00
(F) N=4	26.00	22.37	7.50 - 56.00
Total			
(M) N=40	25.39	12.39	6.00 - 56.00
(F) N=20	25.48	13.40	7.50 - 56.00
N=60	25.42	12.60	6.00 - 56.00



SPORTS INVOLVEMENT DURING THE LAST TWO YEARS

FIGURE 9.

The purpose of examining past sports involvement (Table 9 and Figure 10) was to disclose any age-related trends. The attitude towards physical activity has changed over the years.

There appeared to be no trend with regards to sports participation through the various age groups of Masters swimmers. The slightly lower values for participation in the female age 30 to 39 group and the male age 40 to 49 corresponded with the lower activity levels for these groups over the last two years.

Table 9. Mean, Standard Deviation, and Range of the Level Past Sports Involvement

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	6.00	2.72	1.10 - 10.80
(F) N=12	5.68	3.87	1.50 - 15.30
Age 30-39			
(M) N=13	5.71	4.00	0.60 - 16.30
(F) N=3	4.37	3.07	1.90 - 7.80
Age 40-49			
(M) N=6	4.53	2.68	1.00 - 7.50
(F) N=1	4.50		
Above 50			
(M) N=6	6.05	4.75	0.60 - 12.90
(F) N=4	5.88	4.41	1.40 - 11.60
Total			
(M) N=40	5.60	3.42	0.60 - 16.30
(F) N=20	5.46	3.61	1.40 - 15.30
N=60	5.62	3.46	0.60 - 16.30

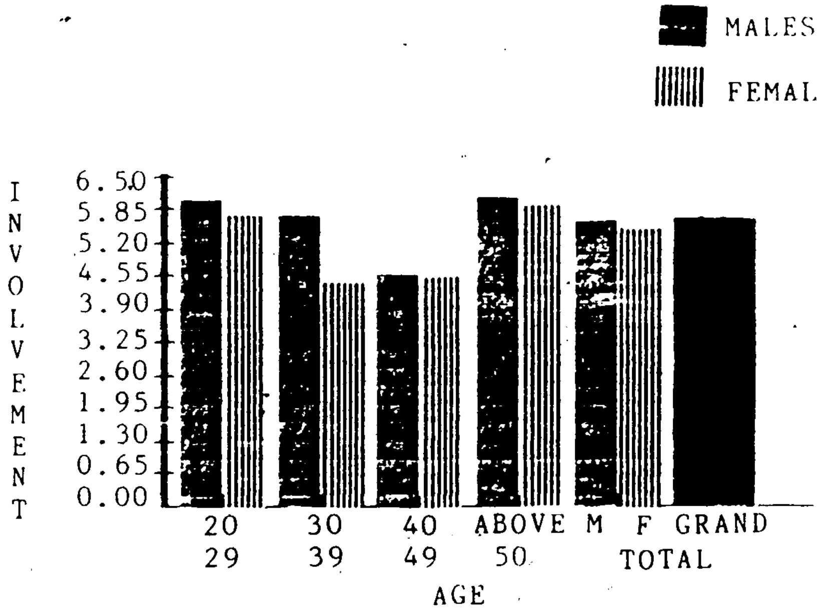


FIGURE 10. PAST SPORTS INVOLVEMENT

SOMATOTYPE

Tables 10 through 12 and Figures 11 through 13 contain the somatotype results. Figure 14 indicates the somatotype values for both sexes on a somatochart. Table 13 shows the division of the somatotype classification for Masters swimmers.

TABLE 10. Mean, Standard Deviation, and Range of the Endomorphy Component

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	3.04	0.86	1.40 - 4.90
(F) N=12	3.95	1.66	1.80 - 7.00
Age 30-39			
(M) N=13	3.15	1.17	1.40 - 5.20
(F) N=3	3.80	1.40	2.40 - 5.20
Age 40-49			
(M) N=6	3.20	1.17	1.30 - 4.30
(F) N=1	7.90		
Above 50			
(M) N=6	3.66	1.44	2.20 - 6.30
(F) N=4	5.25	1.32	3.30 - 6.3
Total			
(M) N=40	3.20	1.08	1.30 - 6.30
(F) N=20	4.39	1.74	1.80 - 7.90

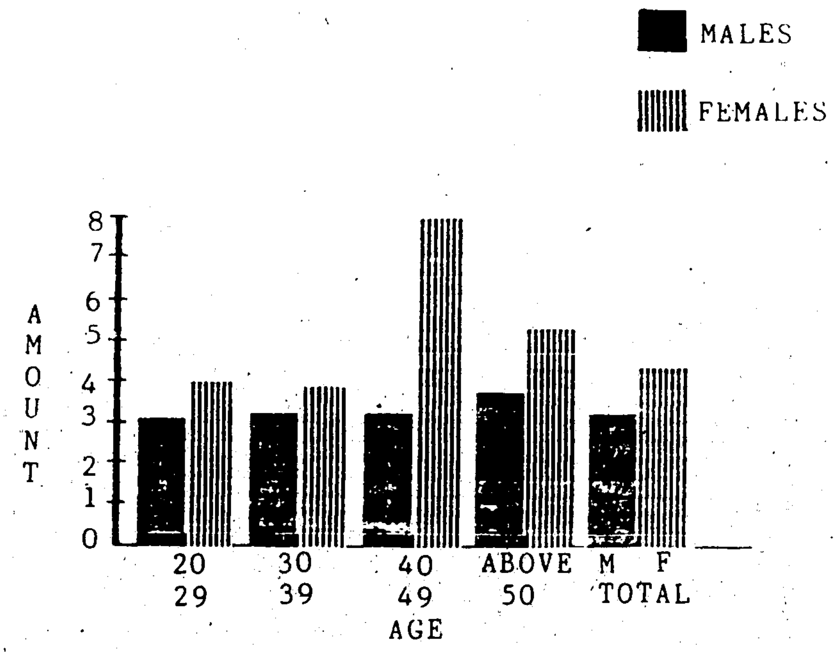


FIGURE 11. ENDOMORPHY COMPONENT

Table 11. Mean, Standard Deviation, and Range of the Mesomorphy Component

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	5.27	1.96	3.50 - 6.50
(F) N=12	4.07	0.67	2.80 - 5.10
Age 30-39			
(M) N=13	5.51	1.19	4.00 - 8.20
(F) N=3	5.53	1.72	4.30 - 7.50
Age 40-49			
(M) N=6	5.21	0.74	4.30 - 6.30
(F) N=1	5.60		
Above 50			
(M) N=6	6.32	0.78	5.20 - 7.60
(F) N=4	4.83	1.00	3.70 - 6.00
Total			
(M) N=40	5.51	1.00	3.50 - 8.20
(F) N=20	4.52	1.04	2.80 - 7.50

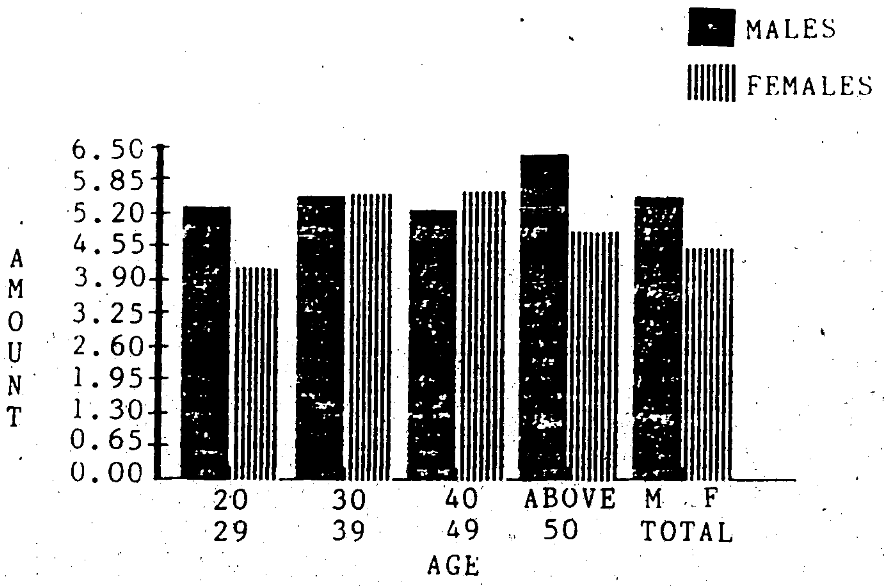


FIGURE 12. MESOMORPHY COMPONENT

Table 12. Mean, Standard Deviation, and Range of the Ectomorphy Component

	MEAN	S.D.	RANGE
Age 20-29			
(M) N=15	2.43	1.06	1.00 - 4.40
(F) N=12	2.69	1.09	0.30 - 4.10
Age 30-39			
(M) N=13	2.32	0.93	0.60 - 3.70
(F) N=3	1.70	1.04	0.50 - 2.40
Age 40-49			
(M) N=6	2.47	0.75	1.30 - 3.40
(F) N=1	1.00		
Above 50			
(M) N=6	1.50	0.70	0.60 - 2.40
(F) N=4	2.20	0.95	1.00 - 3.10
Total			
(M) N=40	2.26	0.96	0.60 - 4.40
(F) N=20	2.36	1.06	0.30 - 4.10

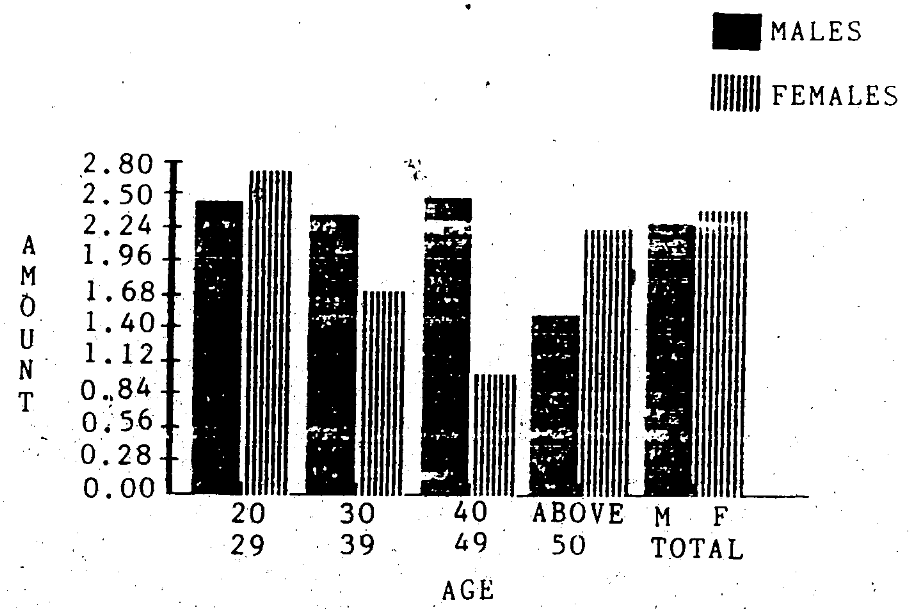
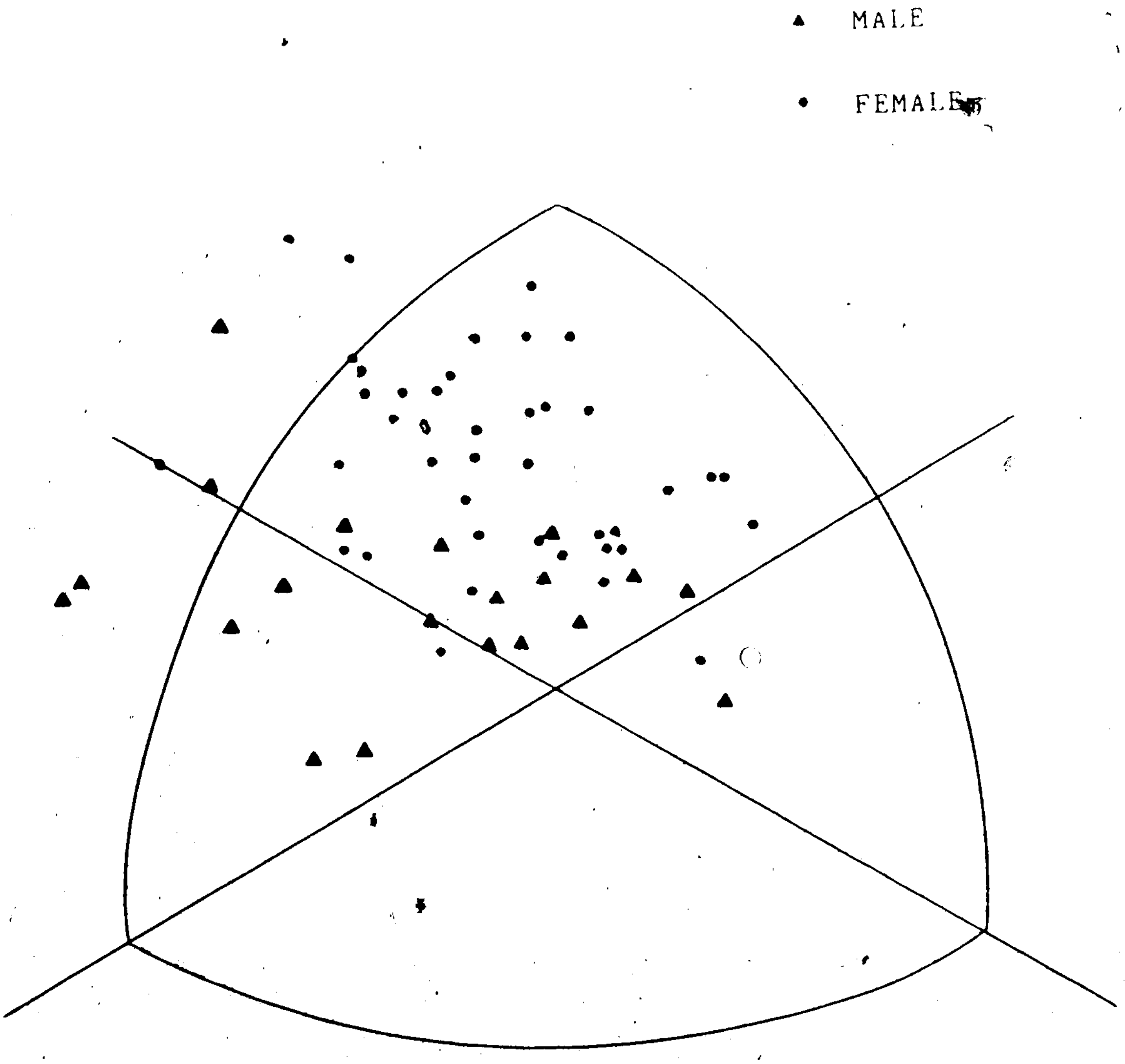


FIGURE 13. ECTOMORPHY COMPONENT

The Masters swimmer males were more mesomorphic and less endomorphic than the females. The ectomorphy component of the two sexes appeared to be equivalent. The data showed no major differences in the somatotype between the different age groups with exception of the endomorphy component which was higher in the females above the 40 to 49 age group.

TABLE 13. CLASSIFICATION OF SOMATOTYPE

TYPE	NUMBER		FREQUENCY	
	Female	Male	Female	Male
Balanced endomorph	1	0	5%	-
Mesomorphic endomorph	5	0	25%	-
Mesomorph endomorph	3	4	15%	10%
Endomorphic mesomorph	4	18	20%	45%
Balanced mesomorph	2	10	10%	25%
Ectomorhic mesomorh	1	6	5%	15%
Mesomorph ectomorph	1	1	5%	2.5%
Mesomorhic ectomorph	1	1	5%	2.5%
Balanced ectomorph	-	-	-	-
Endomorphic ectomorph	-	-	-	-
Endomorph ectomorph	-	-	-	-
Ectomorphic endomorph	-	-	-	-
Central	2	-	10%	-



SOMATOCHART OF MASTERS SWIMMERS

FIGURE 14.

Differences between the two sexes became very apparent upon classification of somatotypes. The females showed a much larger variety of body build types than the males. There was a female representative in nine of the thirteen potential somatotype categories, whereas only six of the categories had male representatives.

The best Canadian norms of somatotype come from a study by Bailey et al.(1982). Upon comparison the Masters swimmer appeared to be less endomorphic but more mesomorphic and ectomorphic than the "average" Canadian. The most common type of Canadian somatotype was the endomorhic mesomorph for the females and the mesomorphic endomorph for the males. Endomorphic mesomorph was the second most common category to the female Masters swimmers. No male Masters fell into the category of mesomorphic endomorph.

DeGaray (et al.,1974) and Carter (1982) respectively have analyzed the somatotypes of swimmers from the Mexico and Montreal Olympic games. The mean somatotype values from these studies and the values from this study are summarized in table 14

TABLE 14. SOMATOTYPE OF SWIMMERS

	MALES	FEMALES
MEXICO	2.1 - 5.0 - 2.9	3.4 - 4.0 - 3.0
MONTREAL	2.1 - 5.1 - 2.8	3.2 - 3.8 - 3.0
EDMONTON	3.2 - 5.5 - 2.3	4.4 - 4.5 - 2.4

The Masters swimmers were more endomorphic and mesomorphic but less ectomorphic than the Olympic swimmers. The sex differences between the Olympic swimmers and the Masters swimmers were almost indentical.

The somatotype distribution of the Montreal Olympic swimmers (Carter,1982) was similar to that of the Edmonton Masters in that males fell into six categories and females into ten. Differences, however, were found between the most common somatotype category. The three most common categories in decreasing order were Balanced mesormorph, Ectomorphic mesomorph and Endomorph mesomorph for the males and Central, Balance mesomorph, and Mesomorph endomorph for the females. One of the females from this study that fell into the Central category was a competitor in the Montreal Olympics.

INTERRELATIONSHIPS OF VARIABLES

Examination of the relationship between selected variables (Tables 15 and 16) reveals only two moderately high correlations: a -0.72 correlation between body fat and the time on the treadmill to reach 60 percent of the estimated maximum heart rate and a 0.76 correlation between the present level of sports participation and the level maintained over the last two years. The correlations marked with an asterisk are significant at the 0.05 level.

TABLE 15.

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT OF SELECTED VARIABLES

	SWIM LEVEL	TREADMILL TIME	% FAT	AGE	PRE-EX H.R.
SWIM LEVEL	----	0.53*	-0.54*	-0.52*	-0.42*
TREADMILL TIME	0.53*	----	-0.72*	-0.37*	-0.47*
% FAT	-0.54*	-0.72*	----	0.51*	0.42*
AGE	0.52*	-0.37*	0.51*	----	0.36*
INVOLVEMENT					
MAST.	0.10	0.30*	0.02	0.33*	0.01
PRES.	0.05	0.18	-0.03	0.01	-0.21*
2YRS.	0.06	-0.36*	-0.18	0.09	-0.18
PAST	0.26*	0.13	-0.10	0.01	-0.20

* $p < 0.05 = 0.21$

TABLE 16.

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT OF SPORT INVOLVEMENT

	MASTERS	PRESENT	PAST
MASTERS	----	0.04	0.07
PRESENT	0.04	----	0.22*
2-YEARS	0.13	0.76*	0.31*

* $p < 0.05 = 0.21$

The correlation of 0.76 between present sport involvement and the last two years of sports involvement revealed that the activity patterns of Masters swimmers were reasonably established. It was not surprising that a low correlation existed between past and present sports involvement. Leisure activities are affected by environmental and economic conditions (Keys, 1967). Opportunity for sport involvement has probably varied over the years. The low correlation between involvement in Masters swimming and the other sports involvement indicated that Masters swimming has attracted a wide assortment of members with respect to the degree and range of sports activity.

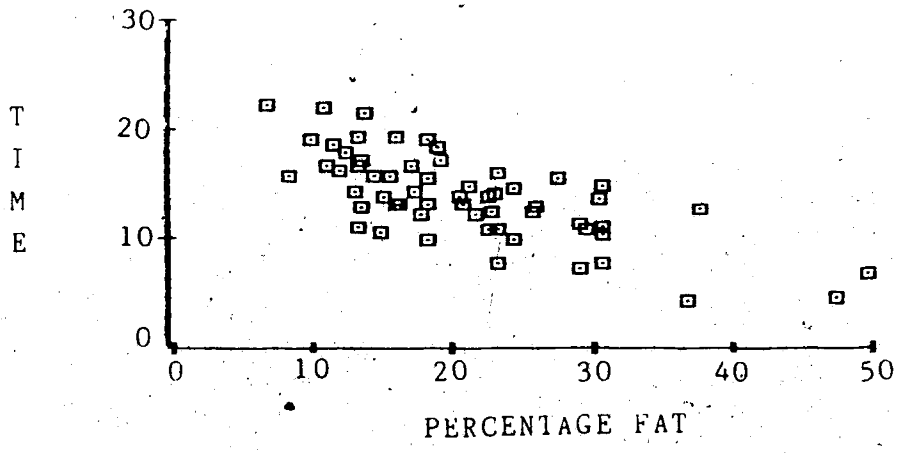


FIGURE 15. TREADMILL TIME VS PERCENT BODY FAT

Figure 15 graphically deplicts the relationship between percent body fat and performance on the treadmill. The individuals with less body fat could do more work before their heart rate reached 70 percent of their estimated maximum. A 1983 study be Mcleod et.al., using 3,174 high school athletes revealed the same negative trend between body fat and performance. They found that performance deteriorated dramatically when body fat was above 10% in males and 19% in females. Parizkova (1977), also found a negative relationship between aerobic capacity and percentage body fat. She concluded that after the age of 12.7, oxygen consumption is more closely related to lean body mass than to total body weight.

Diverse sport participation probably resulted in a 0.53 correlation between swim level and time on the treadmill. For many of the members swimming is a secondary sport. In any case, cardiovascular adaptation can be obtained by a person with a low level of swimming abilty as long as the training principles (American College of Sports Medicine,1978) are adhered to. The extremely low correlation between body fat and involvement in sports could be due to fat storage being related to the balance of energy input and energy output (Astrand and Rodahl, 1977). The energy requirements of both leisure and occupation are important in calculating energy output (Reiff et al.,1967). Dietary habits must be examined for an estimation of energy input.

The -0.52 correlation between age and swim level suggests that there was a trend for the older member to be a poorer swimmer than the younger member. A higher percentage of the younger than older Masters members came from a competitive age group swim background.

The 0.54 correlation between age and fat supports the documentation that body fat increases with age (Pariskova, 1977). The fact that this correlation is not any higher supports the belief that physical activity can offset the degree of age-related fat increase (Oscai,1984).

The low correlation between age and Masters swim involvement supports the view that Masters swimming is for people of all ages (over 20 years). The low correlation between age and the performance on the treadmill supports the finding by Heath et al.(1981) that physical activity can slow VO2 decline.

The pre-exercise heart rates do not correlate highly with any of the other variables. A decrease in resting heart rate is a consquence of increased physical fitness (Astrand,1956) but is not necessarily an indication of physical fitness as there are other reasons for bradycardia.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

Twenty female and forty male Masters swimmers volunteered for body composition assessment, cardiovascular fitness testing and sports involvement analysis. The purposes of this study were to examine the relationship between cardiovascular fitness, body composition and involvement in sport as well as to develop an anthropometric and performance profile on Masters swimmers relative to age and sex.

Body fat was estimated hydrostatically. Somatotype was determined by the Heath-Carter (1975) method. A modified Balke-Ware (1959) treadmill protocol was used to obtain a cardiovascular fitness measure. Sports involvement was obtained by questionnaire. The two Masters swim coaches provided the performance data by ranking the subjects.

The results were correlated and placed in matrices. The mean, standard deviation and range provided the profile. The profile means were graphically displayed.

Within the limitations of this study the major findings were:

1. As a group, the older Edmonton Masters club members were less skilled at swimming than the younger members.

2. The male Edmonton Masters swimmers had higher levels of cardiovascular fitness and lower levels of body fat than the females. The males also scored lower in the endomorphy component than the females. For both sexes, body fat increased with age. The body fat correlated negatively with cardiovascular performance.

3. Males were more involved in the Edmonton Masters Swim Club than females, yet the two were almost equal with regards to present sports involvement. The present sports involvement correlated highly with sports involvement over the last two years.

RECOMMENDATIONS

1. This study should be repeated on other Masters swim clubs to develop a larger profile data base.

2. A longitudinal study is recommended. The subjects in this study remaining active in the club should be remeasured every year.

3. Comparisions should be made beteen Masters swimmers and sedentary co-hort profiles. Differences due to exercise may be noticed.

4. Training differences should be examined by comparing Edmonton Masters' profiles to other Masters' swim club profiles. Masters swimmer's profiles should also be compared to the profiles from other Masters sports.

REFERENCES

American College of Sports Medicine,"Recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults", Medicine and Science in Sports and Exercise, 10:vii,1978.

Astrand,P.O.,"Human physical fitness with special reference to sex and age", Physiological Reviews, 36(3): 307-335,1956.

Astrand,P.,and K.Rodahl,Textbook of Work Physiology.New York: McGraw-Hill Book Company,1977.

Atomi,I., and M.Miyashita."Effects of moderated recreational activities on the aerobic work capacity of middle-aged women". Journal of Sports Medicine, 16: 261-266, 1976.

Bailey,D.A.,J.E.L.Carter,and R.L.Mirwald,"Somatotypes of Canadian men and women",Human Biology, 54(4): 813-828, 1982.

Balke,B., and R.W. Ware. "An experimental study of physical fitness of air force personnel". U.S. Armed Forces Medical Journal, 10(6): 675-688, 1959.

Borkan,G,A., and A.H.Norris. "Biological age in adulthood: comparison of active and inactive U.S. males", Human Biology, 52(4): 787-802, 1980.

Brouha,L. "Physiology of training including age and sex differences", Journal of Sports Medicine, 1-2: 3-11, 1961-62.

Brozek,J., F.Grande, J.Anderson, A.Key. "Densitometric analysis of body composition: revision of some quantitative assumptions". Annals New York Academy of Sciences, 110: 113-140, 1963.

Bruce,R.A. "Exercise, functional aerobic capacity and aging- another view point". Medicine and Science in Sports and Exercise, 16(1): 8-13, 1984.

Canada Fitness Survey, Fitness and Lifestyle in Canada, Ottawa: Government of Canada Fitness and Amateur Sport, 1983.

Carter,J.E.L. The Heath-Carter Somatotype Method. San Diego: San Diego State University, 1975.

Carter,J.E.L., ed.,Physical Structure of Olympic Athletes Part 1:The Montreal Olympic Games anthropometrical project, Medicine and Sport, 16: 1982.

Carter,J.E.L., and W.H.Phillips. "Structual changes in exercising middle-aged males during a 2-year period". Journal of Applied Physiology 27(6): 787-794, 1969.

Davis,J.A.,and V.A.Convertino,"A comparison of heart rate methods for predicting endurance training intensity". Medicine and Science in Sports, 7(4):295-298, 1975.

deGaray,L., L. Levine and J. E. L. Carter, Gentetic and anthropogical studies of Olympic athletes, New York: Academic Press, 1974.

Dehn,M.M., and R.A.Bruce. "Longitudinal variations in maximal oxygen intake with age and activity". Journal of Applied Physiology, 33(6): 805-807, 1972.

deVries,H.A. "Physiological effects of an exercise training regimen upon men aged 52 to 88". Journal of Gerontology, 25(4): 325-336, 1970.

Drinkwater,B. "Women and exercise: physiological aspects", Exercise and Sport Sciences Reviews, 12:21-51,1984.

Drinkwater,D. "Body composition program", Kinanthropometrics research associates, Simmon Fraser University, Burnaby, B.C., 1984.

Edwards,P. "New frontiers in geriatric science fitness in the third age". Canadian Journal of Public Health, 74: 96-99, 1983.

Grimby,G., and B.Saltin. "Physiological effects of physical training". Scand. J. Rehab. Med. 3: 6-14, 1971.

Hartley,A.A, and J.T.Hartley. "Performance changes in champion swimmers aged 30 to 84 years". Experimental Aging Research, 10(3): 141-147, 1984.

Heath,G.W., J.M.Hagberg, A.A.Ehsani, and J.O.Holloszy. "A physiological comparison of young and older endurance athletes".Journal of Applied Physiology:Respirat. Environ. Exercise Physiol., 51(3): 634-640, 1981.

Hollosky,J.O. "Exercise, health and aging: a need for more information". Medicine and Science in Sports and Exercise, 15(1): 1-5, 1983.

Hopkins,K.D., and G.V.Glass, Basic Statistics for the Behavorial Sciences, New Jersey: Prentice-Hall Inc, 1978.

Jones,N., M.Cambell, E.Edwards, and D.Roberstson.Clinical Exercise Testing, Tornoto: W.B.Saunders Co., 1975.

Karvonen,M.J., E.Kentala, and O.Mustala. "The effects of training on heart rate". Annales Medicinae Experimentalis et Biologiae Fenniae, 35: 307-315, 1957.

Keys,A.,"Physical activity-promises and problems in regard to cardiovascular disease",in Physyical Acticity and the Heart, M.J.Karvonen and A.J.Barry, Springfield: Charles C.Thomas Pub.,1967, pp.381-394.

Londeree,B.R., and M.L.Moeschberger, "Effect of age and other factors on maximal heart rate", Research Quarterly for Exercise and Sport, 53(4): 297-304, 1982.

Mcleod,W.D., S.C. Hunter, and B. Etchison, "Performance measurement and percent body fat in the high school athlete", The American Journal of Sports Medicine, 11(10):390-397,1983.

Montoye,H.J.,"Exercise and osteoporosis", in Exercise and Health, Ed. by H.M.Eckert and H.J.Montoye. Champaign: Human Kinetics Publishers,Inc.,1984, pp. 59-75.

Oscai,L.B.,"Recent progress in understanding obesity", in Exercise and Health, ed. by H.M.Eckert and H.J.Monotye, Champaign: Human Kinetics Pub.,1984.

Parizkova,J.,Body Fat and Physical Fitness, Prague: Czechoslovak Medical Press, 1977.

Parizkova,J., and E.Eiselt. "Body composition and anthropometric indicators in old age and the influence of physical exercise", Human Biology, 38: 351-363, 1966.

Pollock,M.L., H.S.Miller, A.C.Linnerud, and K.H.Cooper. "Frequency of training as a determinant for improvement in cardiovascular function and body composition of middle-aged men". Arch. Phys. Med. Rehabil, 56: 141-145, 1975.

Rahe,R., and R.J.Arthur. "Effects of aging upon U.S. masters championship swim performance". J. Sports. Med.. 14: 21-25, 1974.

Rahe,R.H., and R.J.Arthur. "Swim performance decrement over middle life". Med. Science in Sports, 7(1): 53-58, 1975.

Rahe,R.H., and J.E.L.Carter. "Middle-aged male competitive swimmers background and body structure characteristics". J. Sports Med, 16: 309-318, 1976.

Reiff,G.G.,H.J.Montoye,R.D.Remington,J.A.Napier,H.L.Metzner and F.H.Epstein, "Assessment of physical activity by questionnaire and interview", in Physical Activity and the Heart, ed. by M.J.Karvonen and A.J.Barry, Springfield: Charles C. Pub., 1967, pp.336-371.

Robinson,S.,"Experimental studies of physical fitness in relation to age". Arbeitsphysiologie, 10:251-323, 1938.

Ross,W.D., and M.J.Marrfell-Jones. "Kinanthropometry". in Physiological Testing of the Elite Athlete, Edited by J.D.MacDougall, H.A.Wenger and H.J.Green. The Canadian Association of Sports Sciences: 75-115, 1982.

Sidney,K.H., R.J.Shepard, and J.E.Harrison. "Endurance training and body composition of the elderly". The American Journal of Clinical Nutrition, 30: 326-333, 1977.

Sime,W.E., I.T.Whipple, D.M.Berkson, W.C.MacIntyre, and J.Stamler,"Reproducibility of heart rate at rest and in response to submaximal treadmill and bicycle ergometer test in middle-aged men", Medicine and Science in Sports, 4(1): 14-17, 1972.

Smith,E.L., and C.Gilligan. "Physical activity prescription for the older adult". The Physician and Sportsmedicine, 11(8): 91-101, 1983.

Smith,J.J.,and J.P.Kampine, Circulatory Physiology - the essentials, Baltimore: Williams and Wilkins,1984.

Strauzenberg,S.E. "Sport in old age: advantages and risks". J. Sports Med., 21(4): 309-321, 1981.

Suominen,H., E.Heikkinen, P.Vainio, and T.Lahtinen. "Mineral density of calcaneus in men at different ages: a population study with special reference to life style factors". Age and Ageing, 13: 273-281, 1984.

Tzankoff,S.P., S.Robinson, F.S.Pyke, and C.A.Brawn. "Physiological adjustments to work in older men as affected by physical training". Journal of Applied Physiology, 33(3):346-350, 1972.

Vaccaro, P., M. Steven, L. Vandervelden, A. Goldfarb, and D. Clarke. "Body composition and physiological respones of masters female swimmers 20 to 70 years of age". Research Quarterly for Exercise and Sport, 55(3): 278-284, 1984.

Vallbona, C., and S.B. Baker. "Physical fitness prospects in the elderly". Arch. Phys. Med. Rehabil., 65: 194-200, 1984.

Wells, C.L. Women, Sport and Performance, Champaign: Human Kinetics Publishers, Inc., 1985.

White, G.M., and R.J, Young. "Effects of a 12 week exercise program on cardiorespiratory and body composition variables in nonobese young and middle-aged females". Brit. J. Sports. Med., 12(1): 27-32, 1978.

Wilmore, J.H. "Appetite and body composition consequent to physical activity". Research Quarterly for Exercise and Sport, 54(4): 415-425, 1983a.

Wilmore, J.H. "Body composition in sport and exercise: directions for future research". Medicine and Science in Sports and Exercise, 15(1): 21-31, 1983b.

APPENDIX

SUBJECT CONSENT FORM

I desire to engage voluntarily in a physical fitness assessment to enable a profile to be developed on Edmonton Masters Swimmers. The assessment will include a physical work capacity test, body composition analysis and a questionnaire.

I understand that for the physical work capacity test I will walk on a treadmill until I have acheived a heart rate equal to HRrest + 0.60(HRmax - HRrest). Heart rate maximum equals 210 - (age x 0.65). The test will commence with a three minute walk at 3.0mph at zero grade; thereafter, the speed will remain constant but the mill will be raised 3% every additional three minutes. The test will be discontinued once I reach the desired heart rate, if I become distressed in any way or if I develop any abnormal response. I realize that as with any type of fitness test there are potential risks. These include shortness of breath, lightheadiness, fainting, nausea, chest discomfort and muscle cramps. Every effort will be made to conduct the test in such a way as to minimize the risk and discomfort.

The body composition analysis will involve hydrostatic weighing and skinfolds. The questionnaire will deal with my past and current sports involvement. At any time, I will be able to discontinue participation in the project or some of its parts without prejudice.

All of the data from this study will be confidential, however, the results may be used for scientific purposes.

I have read the foregoing and I understand it. All questions which have occurred to me have been answered to my satifaction.

SIGNED ....DATE.............

NAME ....

Physical Activity Readiness Questionnaire (PAR-Q)*

PARTICIPANT IDENTIFICATION

PAR Q & YOU

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

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

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

YES	NO		
☐	☐	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 over age 65 and not accustomed to vigorous exercise?

If You Answered

YES to one or more questions

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

programs

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

- unrestricted physical activity, probably on a gradually increasing basis.
- restricted or supervised activity to meet your specific needs, at least on an initial basis. Check in your community for special programs or services.

NO to all questions

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

- A GRADUATED EXERCISE PROGRAM - A gradual increase in proper exercise promotes good fitness development while minimizing or eliminating discomfort.
- AN EXERCISE TEST - Simple tests of fitness (such as the Canadian Home Fitness Test) or more complex types may be undertaken if you so desire.

postpone

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

---

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

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

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

SPORTS INVOLVEMENT QUESTIONNAIRE

MASTERS SWIMMING INVOLVEMENT

years of membership	no. of practices attended a week	average duration of practice	approx mileage

ADDITIONAL ACTIVITY

type	frequency per week	average duration of each session

PAST SPORTS INVOLVEMENT

type	starting age	finishing age	frequency per week	duration of practice

RAW DATA OF FEMALES

AGE	LEVEL	RESTING HEART RATE	%FAT	TIME	SOMATOTYPE en.	mes.	ec.
20	8	36	19.3	17.2	1.8	2.8	4.1
22	5	54	21.7	12.2	4.3	4.2	2.4
22	5	60	29.7	10.7	4.2	4.2	3.2
25	7	60	24.5	9.8	5.6	3.5	2.9
25	9	48	21.2	14.7	3.0	3.9	3.3
25	7	69	17.8	12.1	3.5	3.2	2.9
26	7	60	13.5	12.9	2.4	4.2	3.4
27	5	72	29.1	7.2	6.3	4.9	1.8
27	8	54	30.7	10.9	7.0	5.1	0.3
28	8	54	11.4	18.5	1.9	3.9	3.8
29	8	54	22.7	10.7	4.0	4.8	1.5
29	8	66	15.0	10.5	[illegible].4	4.1	2.7
33	6	54	15.6	15.8	2.4	4.3	2.4
35	4	66	30.7	10.1	5.2	7.5	0.5
35	6	68	29.2	11.1	3.8	4.8	2.2
44	5	66	37.8	12.5	7.9	5.6	1.0
50	2	66	47.7	4.4	5.8	6.0	1.0
52	7	48	24.5	14.5	3.3	4.4	3.1
55	3	66	49.8	6.5	6.3	3.7	2.8
57	6	60	30.6	13.5	5.6	5.2	1.9

RAW DATA OF FEMALES

AGE	SPORTS INVOLVEMENT			
	mast.	pres.	2yrs.	past
20	1.8	18.5	25.0	9.4
22	3.0	21.8	43.0	5.1
22	2.0	5.5	20.0	1.5
25	3.0	7.0	9.0	3.0
25	3.3	10.0	18.0	5.7
25	1.5	6.8	28.0	7.5
26	7.5	11.0	40.0	2.7
27	7.0	7.5	18.0	2.6
27	3.0	11.5	12.0	7.4
28	20.0	6.7	43.0	5.1
29	15.0	6.8	38.0	15.3
29	10.0	8.0	16.0	2.8
33	1.2	5.0	17.5	7.8
35	10.0	5.0	20.0	3.4
35	6.0	8.0	22.0	1.9
44	15.0	8.5	36.0	4.5
50	1.0	6.0	10.5	1.4
52	38.3	26.8	56.0	11.6
55	1.0	2.0	7.5	3.8
57	4.5	11.0	30.0	6.7

RAW DATA OF MALES

AGE	LEVEL	RESTING HEART RATE	%FAT	TIME	SOMATOTYPE		
					en.	mes.	ec.
20	3	54	13.1	14.2	2.8	6.5	1.7
23	7	48	13.2	16.7	2.7	4.7	3.2
24	4	--	9.5	----	3.3	5.0	3.1
25	9	54	6.8	22.3	1.4	4.4	4.0
25	8	42	8.2	15.8	2.7	4.6	3.3
25	9	60	18.3	19.0	3.6	6.3	1.4
26	8	72	18.2	15.5	4.9	5.1	2.1
26	9	42	17.5	14.3	2.2	4.2	3.1
26	9	60	18.9	18.3	2.9	5.8	1.2
27	7	54	9.8	19.0	2.5	3.5	4.4
27	9	60	18.2	13.2	3.6	5.1	2.2
27	7	54	13.6	17.2	3.3	5.8	2.2
29	7	66	13.4	19.3	3.8	6.4	1.0
29	9	60	16.1	13.0	3.8	6.4	1.1
29	9	48	16.0	19.3	2.1	5.7	2.5
30	4	48	11.9	16.3	2.2	6.2	1.7
30	9	45	13.3	11.0	2.9	4.5	3.1
30	5	60	16.3	13.0	3.0	6.1	2.5
31	8	54	17.1	16.8	4.4	8.2	0.6
31	7	48	13.7	21.5	2.0	6.8	1.7
31	4	78	25.7	12.3	5.2	5.9	1.2
32	8	60	15.1	13.7	2.9	6.2	2.6

continued

RAW DATA OF MALES

AGE	LEVEL	RESTING HEART RATE	%FAT	TIME	SOMATOTYPE en.	mes.	ec.
32	9	60	23.1	14.0	4.5	5.1	1.5
33	7	50	10.7	22.0	1.4	5.0	3.7
35	7	54	26.1	12.8	3.4	4.7	2.3
35	5	54	20.5	13.8	4.4	4.0	2.7
38	8	48	11.1	16.8	2.0	4.9	3.5
39	6	48	23.2	16.0	2.7	4.1	3.1
40	8	54	23.4	7.5	4.3	4.7	2.9
41	8	54	27.6	15.5	4.0	6.3	1.3
41	7	66	22.7	13.8	3.4	5.5	2.2
43	8	54	20.9	13.2	3.9	5.7	2.1
44	7	60	12.5	18.0	2.3	4.3	2.9
45	8	54	14.4	15.8	1.3	4.8	3.4
59	7	72	18.4	9.8	3.2	6.3	1.6
65	1	60	36.9	4.2	3.9	6.1	1.5
67	5	72	23.2	10.8	2.7	5.2	2.1
68	1	79	30.8	7.5	6.3	6.3	0.6
69	4	66	30.9	14.8	3.7	7.6	0.8
71	3	54	22.8	12.3	2.2	6.4	2.4

RAW DATA OF MALES

AGE	SPORTS INVOLVEMENT mast.	pres.	2yrs.	past
20	0.5	10.0	17.0	4.4
23	4.5	9.5	22.0	1.1
24	2.3	5.5	24.0	5.8
25	9.0	6.0	28.0	4.8
25	7.0	4.0	22.0	2.4
25	4.0	30.0	52.0	8.2
26	8.0	5.0	14.0	5.8
26	2.0	1.8	20.0	10.8
26	3.0	3.0	6.0	9.9
27	9.4	9.8	37.0	6.4
27	18.0	7.5	26.0	6.8
27	6.0	5.0	15.0	2.1
29	4.5	7.1	18.0	5.2
29	22.5	18.5	27.0	8.2
29	12.0	8.0	26.0	8.1
30	2.3	14.5	35.0	5.1
30	10.0	8.0	18.0	7.2
30	1.5	1.0	9.5	3.7
31	9.0	7.8	22.0	5.0
31	4.5	18.5	44.0	9.6
31	2.0	16.0	26.0	4.4
32	6.0	5.0	14.0	0.6

continued

RAW DATA OF MALES

AGE	SPORTS INVOLVEMENT			
	mast.	pres.	2yrs.	past
32	21.0	3.0	12.0	16.3
33	5.0	17.5	48.0	3.6
35	12.0	4.0	20.0	2.1
35	6.0	6.0	24.0	7.1
38	11.3	7.8	24.0	3.1
39	10.0	26.3	56.0	6.5
40	23.4	5.9	18.0	6.1
41	4.5	19.0	42.0	6.2
41	9.0	3.0	28.0	4.9
43	13.1	3.0	8.0	1.5
44	2.3	12.3	26.0	7.5
45	27.0	6.5	14.0	1.0
59	15.0	7.1	36.0	4.6
65	6.0	16.0	26.0	2.4
67	4.5	16.0	51.0	10.6
68	12.8	3.5	14.0	5.2
69	38.3	6.8	16.0	0.6
71	5.0	8.0	30.0	12.9