MASTERS SPORT

Training For Enhanced Performance

by Peter Reaburn PhD

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My wife Claire, herself a world class masters distance swimmer, kept my writing feet on the ground when I drifted off into "academic-speak" on those late nights at the computer terminal. Her support and understanding has contributed greatly to the final result.

Betty Menzies and Griffith ('Griff') Young, masters athletes from running and swimming, provided both constructive criticism and insightful comments that contributed greatly to the completion of the book.

Finally, to all the masters athletes I have spoken to, workshopped with, competed against, trained with, and particularly researched on - you have all contributed greatly to this book in your own way.

"Man does not cease to play because he grows old
Man grows old because he ceases to play"

George Bernard Shaw

PREFACE

(WHAT THIS BOOK IS ALL ABOUT!)

This book is a labour of love. As a competitive masters athlete and sports scientist, I was amazed at the lack of written literature available to those of us who want to know more about the aging process, its affect on sports performance, and more importantly, what we can do to prevent or slow the decline in performance. After completion of my PhD in Exercise Physiology I was approached by Terry Carlson, the Queensland President of ACHPER, to synthesize my experiences and knowledge of masters athletes into a book that an older athlete could easily pick up and read. I hope I have achieved this goal.

The objective of the book is to enable the masters athletes who read it to both improve performance and better understand their body's responses to exercise as they age. Every attempt has been made to relate current scientific thinking and research to the masters athlete. While little scientific research is available that specifically relates to the older athlete, I hope this book goes a long way to bridging the gap between sports science and the masters athlete. Enjoy the contents and keep exercising - age shall not weary us!

Peter Reaburn PhD

ABOUT THE AUTHOR

(WHO IS THIS GUY?)

Peter is a lecturer in Exercise Physiology within the Department of Human Movement Studies at The University of Queensland in Brisbane. He received his PhD in 1994 with his research area being the strength, speed and endurance capacities of the lifetime athlete. He is a member of the National Coaching Panel for AUSSI Masters Swimming in Australia and was on the Medical Committee for the 1994 World Masters Games. Together with wife Claire, he is the editor of a bi-monthly masters sport publication ("The Masters Athlete") which aims to bridge the gap between masters sport and sport science.

As a masters athlete Peter has been world-ranked in the 1500m freestyle (35—39 years), has won numerous open water swims, has completed over 20 half marathons (PB 1-17-25) and when time was available won the 1986 Cairns Ironman Triathlon. He still enjoys "keeping the youngsters honest" and competing in triathlon teams where his veteran's team won the 1994 Noosa triathlon. His long term goal is to compete in and complete the gruelling Hawaiian Ironman.

Peter is married with two children and enjoys time with his family, swimming, running, surfboard riding, watching elite sport on television, and reading Gerald Seymour novels.

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CHAPTER 1
THE PHYSIOLOGY OF AGING

(NOT A PRETTY SIGHT!)

As a competitive masters athlete, I am feeling the pinch! The question I ask myself is - why am I getting slower? Sure, I have a family, a career, less time to train, and possibly the motivation is waning a little, but I still feel strong when I race. So why am I slowing down in the swim and run races that I compete in? Why are those 30 year-old "youngsters" beating me? The purpose of this chapter is to suggest physiological reasons why we might be slowing. The purpose of the book is to suggest ways that we as masters athletes might be able hold back the inevitable slowing down process or even improve our times of years ago through a scientific approach to our training.

INTRODUCTION

Age-related declines in endurance, speed, power, strength, and flexibility lead to decreased sports performance in the masters athlete. Age-related changes in our body composition, specifically reduced muscle mass and increased fat mass, also contribute to decreased sports performance. Accompanying these declines in sports performance is an age-related decrease in participation in sport, as well as a decrease in occupational and leisure time activity. Thus, it might be suggested that the age-related declines in speed, power, strength and endurance may be partly explained by this observed decline in the intensity and frequency of physical activity. This suggestion is supported by evidence from studies of young athletes who stop training - they exhibit many of the changes in endurance, speed, power and strength that are observed in older people as they age.

Sports performance is determined by fitness-related components such as aerobic, anaerobic, and strength capacities. These capacities are in turn affected by numerous factors that are affected by the aging process. This chapter will examine these factors and how they affect endurance, speed, and strength.

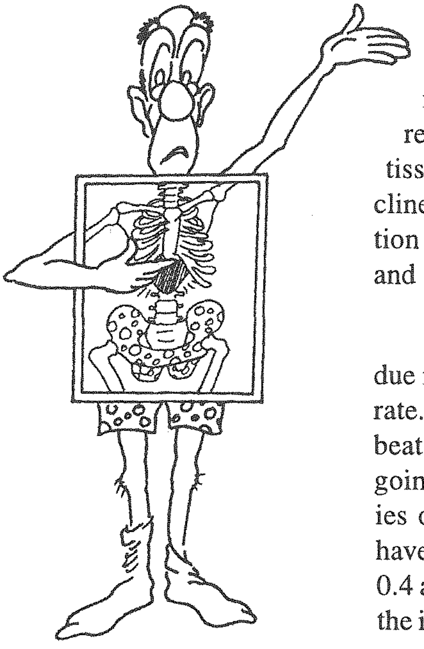
REASONS FOR DECLINES IN ENDURANCE

Endurance and aging non-athletes - the bad news!

In sports science we discuss the capacity for endurance in terms of VO2max or maximal aerobic power. VO2max is a term both masters and young athletes use a lot but with no real understanding of what it means. VO2max is the maximal volume of oxygen that can be transported to and consumed by, the working tissues. It is dependent upon the ability of the cardiovascular system to supply oxygen to exercising muscles and the ability of those working muscles to extract the available oxygen. It is expressed as a volume of oxygen (ml) per kilogram of body weight (kg) per unit of time (min) with values in young elite male distance runners of 70-80 millilitres of oxygen per kilogram per minute and in young elite female runners of 60-70 millilitres of oxygen per kilogram per minute. Elite male masters runners (60-65 years) possess figures of around 50-55 units. That is, an elite older male runner may deliver up to 55 millilitres of oxygen to each kilogram of his bodyweight per minute. As you can see, this means significantly less oxygen is available to the older athletes muscles compared to the 70-80 units available to the elite young male runner.

Unfortunately for us, research studies suggest a fairly uniform rate of decline in VO2max with age of between 0.40-0.50 millilitres of oxygen per kilogram per minute per year in aging non-athletes, and about 0.20-0.25 units per year in masters athletes. This may be due in part to a tendency to gain weight consistently between the ages of 20 to mid-forties. This weight gain, combined with reduced physical activity levels during these years, may also accelerate the rate of decline in VO2max observed during these years in older non-athletes.

VO2max is the product of three factors. These factors are firstly, maximal heart rate (MHR), secondly, maximal stroke volume (SV) or the maximal volume of blood pumped per beat of the heart, and thirdly maximal arteriovenous oxygen difference (A-V02 diff) - the amount of oxygen extracted from the blood by the working tissues. The amount of oxygen extracted by the muscles is further influenced by a variety of factors including the amount of muscle mass, the capacity of the blood to transport and relinquish oxygen, and the capacity of the working tissues to take up and use the available oxygen. Declines in any of these factors may lead to the reduction in VO2max observed with age in non-athletes and the masters athlete.



Firstly, the decline in VO2max with age may be due in part to an age-related decline in maximal heart rate. As you might expect, the less often your heart beats, the less blood, and therefore less oxygen is going to be available to the working muscles. Studies on both aging non-athletes and masters athletes have noted decreases in maximal heart rate of between 0.4 and 0.95 beats per minute per year, depending on the individual genetics. This decline in maximal heart rate with age has been shown to account for approximately 30 to 50 percent of the observed decrease in VO2max in older non-athletes. Although the probable mechanism responsible for the age-related decrease in MHR is decreased sensitivity of heart muscle to adrenaline (a direct stimulator of heart muscle), decreased nervous system stimulation may also be involved.

While the books suggest MHR to be equal to 220 minus your age, I have seen 52 year-old runners with MHR's in the 190's and a 28 year-old ironman with a maximum running heart rate of 178. It is a totally individual and event-specific figure. The chapter on endurance will discuss ways to establish MHR for yourself.

The second factor that may lead to a reduction in VO2max in masters athletes is a reduction in maximal stroke volume or amount of blood pumped per heart beat. Stroke volume declines with advancing age in aging non-athletes. However, it has been suggested that this decrease may be related to disease and may not be observed in healthy older people such as masters athletes.

Finally, there appears to be general agreement that the ability of the muscles to extract oxygen in older non-athletes is reduced by about 10% compared to the young non-athlete. Several factors may contribute to this reduced ability of the muscles to extract oxygen. Firstly, while there appears to be no change in the energy production ability per unit of muscle mass, there is an age-related loss of total muscle mass. Less muscle mass means less oxygen extracted.

Secondly, age-related decreases in the number of capillaries (small blood vessels) and reduced muscle blood flow may result in a reduced oxygen availability at the muscle level. These muscle capillaries serve as the final pathway for oxygen and energy source (glucose, fats) exchange between blood and muscles. The reduced ability of the older adult to extract oxygen may also be a result of a reduced ability to redirect blood flow during exercise from the non-active tissues (eg. unused muscles, gut, and skin) to the exercising muscles. This is most likely due in turn to a reduction in blood vessel elasticity or a reduced capacity for enlargening of blood vessels in the active muscles.

Thus, it would appear that endurance capacity is reduced in older non-athletes due primarily to age-related declines in maximal heart rate, and to a lesser extent by age-related declines in both the volume of blood pumped per heart beat and the ability of older muscles to extract oxygen.

The effect of endurance training in aging non-athletes - the good news!

Research studies in the 1950's and 60's noted no increases in VO2max in elderly male and female non-athletes undertaking a low intensity endurance training program. However, in these studies work efficiency improved, while resting pulse decreased, suggesting that the training intensity may have been too low to produce any increases in VO2max. The extent of training adaptations in VO2max depends greatly on training intensity for both younger and older people. Recent studies using higher intensity endurance training have shown significant increases in VO2max in the both men and women over 60 years of age. Thus, endurance training can increase VO2max in older non-athletes, as long as the intensity is high enough. The American College of Sports Medicine recommends the minimal intensity as 60-65% of maximal heart rate (220-age), 3-4 times per week, for a minimum of 30 minutes as the guidelines to improve endurance in healthy older non-athletes. This intensity is very easy to achieve through brisk walking.

At present the factors responsible for increases in VO2max in aging non-athlete remain unclear and inconclusive. In younger people, increased VO2max appears due to increases in both stroke volume and the muscles oxygen extraction ability, each contributing to the same extent. While the evidence is not conclusive, high intensity endurance training in older non-athletes may also result in increases in both the muscles oxygen extraction ability and stroke volume. Increases in either or both of these factors would contribute to increases in maximal aerobic power in older non-athletes undertaking an exercise program.

Thus, the majority of recent research strongly suggests muscle and heart adaptations do take place in aging non-athletes who undertake an exercise program of high enough intensity.

Endurance and the masters athlete

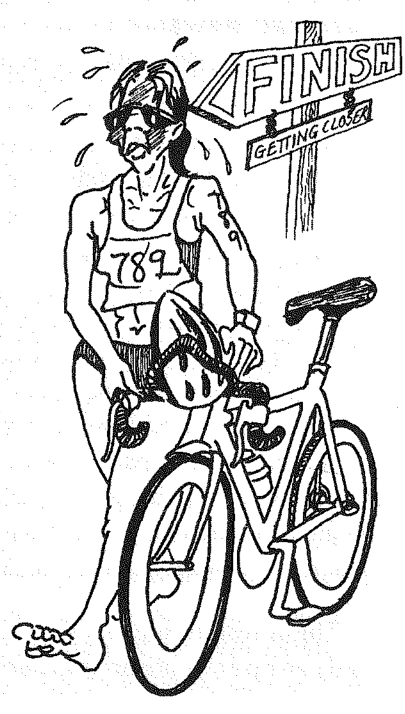
Unfortunately for we older endurance athletes, an age-related reduction in VO2max has also been shown to occur in masters athletes who maintain high intensity endurance training into older age. However, while the decline in VO2max appears inevitable with aging, the decrease in the masters athlete is only half that observed in aging non-athletes. Importantly, the VO2max of these masters athletes is superior compared to non-athletes of a similar age.

The suggested reasons to explain this inevitable drop in VO2max of the masters athlete are a decrease in any number of the following factors - maximal heart rate, stroke volume, or the muscles' oxygen extraction ability. It is strongly suggested from both my own and previous research that the decline in maximal heart rate is solely responsible for differences in VO2max between younger and older endurance athletes. Unfortunately, maximal heart rate has been shown to decrease at the same rate in both aging athletes and non-athletes. The unfortunate outcome of this finding is that maximal heart rate appears untrainable.

As noted earlier, another factor influencing VO2max is stroke volume or the volume of blood pumped per beat of the heart. The available evidence suggests maintenance or a slight decrease in maximal stroke volume in the aging masters athlete. Finally, there also seems general agreement that the muscles oxygen extraction ability is maintained or slightly reduced in masters endurance athletes. The lower arteriovenous oxygen difference (oxygen extraction ability) observed in older versus younger endurance athletes may be due to declines in a number of factors that will be discussed below.

A decline in muscle capillarization has been shown to occur in older non-athletes. The lower number of capillaries per fibre in the elderly lowers the capacity to transport oxygen, nutrients, and waste products to and from the muscle. A study of 33 aged (42-72 years) male endurance runners over an 18 year period noted the still active older athletes had a higher degree of capillarization compared to young as well as older non-athletes. Another recent study also observed greater capillarization in masters endurance runners compared with younger runners matched for training and performance. This would suggest a maintenance of capillary density in masters athletes who maintain high intensity endurance training.

While the number of capillaries in a muscle contributes to muscle blood flow and maximal aerobic power, other muscle factors also play an important part. Muscles are made up of basically two types of muscle fibres - slow twitch or endurance fibres and fast twitch fibres which are for speed. Elite masters marathon runners will have high percentages of slow twitch fibres while the "speed demons" will have high percentages of fast twitch fibres. Muscle fibre composition (fast and slow twitch fibres) of older runners is the same as that observed in younger runners. However, a recent study observed 34% larger slow twitch fibres (the endurance fibres) in masters endurance runners compared to that observed in young runners. The bigger slow twitch fibres in the masters endurance runners has also been observed in elite younger runners who trained for long duration and at high intensity. While I personally have not observed slow twitch fibre enlargement in lifetime runners compared to younger runners, I have observed a decrease in the size of the fast twitch (speed) fibres in older endurance and sprint athletes compared to similarly-trained younger runners. This would help explain decreased speed in the older endurance athlete since the fast twitch fibres are the speed and power producing fibres. It would also strongly suggest the need for strength (muscle enlargening) training in the off-season for the older sprint and endurance athlete because these fast twitch fibres are the ones enlarged when we do strength training.



Most studies of masters athletes have generally examined older people who may have taken a break from training during their lifetime or commenced training and competition after 40 years of age. During this break from training, the factors influencing aerobic performance may have declined to a similar extent as those observed in aging non-athletes. A number of studies have examined lifetime athletes who have maintained exercise training throughout their lives without any breaks in training. Sports scientists have observed VO2max values in these lifetime athletes to be comparable with younger endurance-trained athletes. Furthermore, the maximal aerobic power of these athletes was significantly higher than that recorded for similar-aged masters athletes who commenced physical training later in life.

The most comprehensive study on lifetime athletes was conducted in Scandinavia in 1980. Twenty-two lifetime-trained endurance athletes (34-70 years) and 22 non-athletes (33-68 years) were compared over a number of physiological (VO2max, vertical jump, grip strength), fibre type, and biochemical parameters. Compared to the non-exercising group, the lifetime athletes displayed higher VO2max and vertical jumps, higher percentage of slow twitch fibres and higher energy-producing chemical activity levels. While genetics may play a role in these observed differences, these results lend support to the concept that the declines in aerobic capacity observed with aging may be due to inactivity, reduced training intensity, or disease, and are thus preventable to some degree with continued endurance training throughout life. The moral of this story - never, never, give up that endurance training!

REASONS FOR DECLINES IN SPEED AND POWER

Speed, power and the aging non-athlete - more bad news!

Speed and power development are related to anaerobic capacity. Anaerobic capacity is the ability to produce energy quickly in the absence of oxygen. Few studies have examined the changes in anaerobic capacity in older people. In the mid-1980's a Canadian study investigated 50 males and 50 female non-athletes aged 15-71 years who performed a standard maximal 30-second cycle test. The amount of work performed in 30 seconds, the measure of anaerobic capacity, declined for both males and females by about 6 percent per decade, strongly suggesting that anaerobic or speed capacity decreases with age. The same study showed that anaerobic capacity (total work done in 30 seconds) was related closely to thigh size, to VO2max, and to the amount of time spent in leisure activity. It would follow that an age-related decrease in both muscle mass and leisure activity may help explain the decline in anaerobic capacity observed in these older non-athletes. Myself and Dr David Jenkins, another sports scientist at The University of Queensland, recently published an article in Sports Coach (March, 1994) that showed a significant decline in anaerobic capacity in veteran Australian track and field athletes (Figure 1).

These results suggest that decreases in maximal short term exercise capacity (speed) and power are an inevitable consequence of aging. As we shall see later in

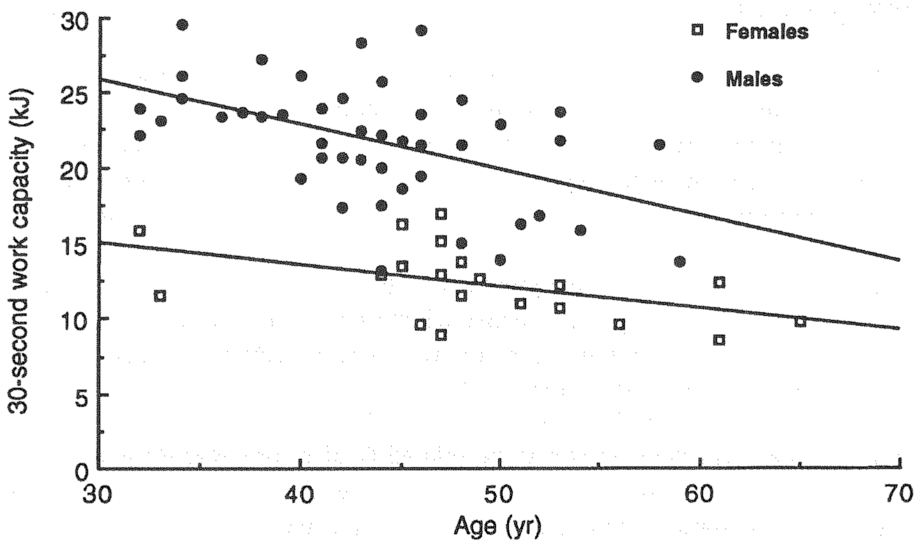


Figure 1. Maximal 30-second work capacity of masters track and field athletes

the speed and power chapter, there is something we can do about this decline in speed as we age — resistance or weight training.

This age-related decrease in anaerobic capacity may be due to a decline in any one or all of the factors that influence anaerobic capacity. These include total muscle mass, muscle cross-sectional area or size, strength, fibre type and fibre area, training, fuel availability, accumulation of reaction products such as lactic acid, the oxygen delivery system, and heredity which has been suggested to explain up to 70-75 percent of speed.

While we can't do too much about heredity except blame mum and dad, age-related declines in both active muscle mass and muscle cross-sectional area have been observed in both non-athletes and masters athletes. These declines will compromise anaerobic capacity and therefore speed. This decrease in muscle mass may be due to either a reduction in muscle fibre number, a reduction in muscle fibre cross-sectional area, or both.

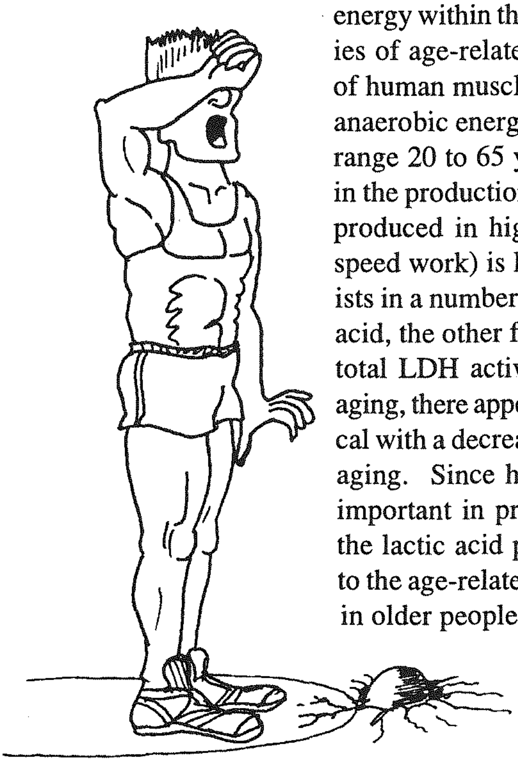
Perhaps the least controversial finding in studies of aging muscle is an age related loss of muscle fibre number. Direct evidence for loss of muscle fibres has been obtained by counting all the muscle fibres in autopsied whole thigh muscle in people who died in car accidents in Scandinavia and who ranged in age from 15 to 83 years. The researchers in this study noted a reduction in the total number of muscle fibres with age with both slow or fast twitch fibres being equally affected.

No similar research has been undertaken on masters athletes - unless anyone wants to volunteer a thigh!?.

The decrease in muscle size may also be due to a reduction in muscle fibre size. Several studies agree that slow twitch fibre size changes little up to the age of 60-70 years in non-athletes. However, significant decreases in the size of the fast-twitch muscle fibre (speed and force producers) have been observed in both older non-athletes and masters athletes, particularly beyond 70 years of age. Thus, the decrease in muscle size appears to be caused by both a loss and reduction in the size of the muscle fibres, particularly of the fast twitch fibres. There is a strong relationship between anaerobic capacity (speed) and fast twitch fibre composition and size. Therefore, an age-related decrease in these factors would be expected to reduce anaerobic capacity and speed in the older athlete.

Strength has also been shown to be related to anaerobic capacity and power and speed. Declines in strength in both older non-athletes and masters athletes would therefore also contribute to the declines in anaerobic capacity observed with aging. Strength is also related to the size and number of fast twitch fibres. As we have seen above, decreases in size and number of fast twitch fibres occurs with age. This **STRONGLY** suggests the need for hypertrophy (muscle enlargening) and strength training in the older athlete, particularly the older speed or power athlete.

Anaerobic capacity or speed is also influenced by the availability of chemical energy within the muscle. The most comprehensive studies of age-related changes in chemical energy potential of human muscle suggest that the chemicals involved in anaerobic energy production do not change over the age range 20 to 65 years. However, one chemical involved in the production of lactic acid (a substance needed to be produced in high concentrations during high intensity speed work) is lactate dehydrogenase (LDH). LDH exists in a number of forms - one form for producing lactic acid, the other for removing it from the muscles. While total LDH activity does not appear to be altered with aging, there appears to be a shift in the forms of the chemical with a decrease in the lactic acid producing form with aging. Since high levels of lactic acid production are important in producing anaerobic energy, a decline in the lactic acid producing form of LDH may contribute to the age-related decline in anaerobic capacity observed in older people.



The availability of fuels has also been suggested as a factor affecting anaerobic or speed performance.

Glycogen is the only fuel for lactic acid production and is thus important for the sprinters and middle distance athletes who use anaerobic energy. No evidence is available to suggest decreased glycogen (stored carbohydrate) concentrations in the elderly. However, a study in 1980 suggested that older people's muscles contain less immediate energy stores (creatine phosphate and adenosine triphosphate) than younger people. These chemicals are used in short term (1-20 seconds of flat out work). These findings may also contribute to the age-related decrease in anaerobic capacity.

A 30-second sprint bike test is widely used as the method of measuring anaerobic capacity. During such tests some oxygen contributes to energy production. A number of studies have suggested that the oxygen energy contribution to the maximal 30-second test may range between 9 and 44%. Maximal aerobic power (VO2max) is therefore a strong contributor to anaerobic or speed performance, with the longer events (1k time trial on the bike track, 100-200m swims or 400-800m runs) requiring even greater amounts of oxygen than that suggested above for the 30-second bike test. Masters athletes display an age-related decline in maximal aerobic power and this may therefore lead to a smaller aerobic energy contribution to a 30-second anaerobic test. This would STRONGLY suggest the need for a degree of endurance fitness in the older sprint athlete. I would suggest this be developed in the off and pre-season before the maximal speed training commences.

The effect of speed and power training in aging non-athletes - some good news!

While the effects of endurance training on previously inactive older people have been well documented, studies examining the effects of anaerobic or speed training on a similar group are few. To date, one study has examined changes in anaerobic capacity with training in the aged. Aerobic interval training at 50-85 percent of VO2max, three times per week for 12 weeks produced a significant increase in total work output during a 30 second anaerobic capacity test in 60-70 year old men. Since the 30-second test also has an aerobic contribution, it is possible that the observed increase in anaerobic capacity may have been due to the more efficient aerobic system which showed a significant increase in the same group following training.

As noted earlier we recently undertook an eight-week strength training program in veteran male and female track sprinters and observed significant gains in strength and anaerobic performance as measured by 100 and 300 meter track performance. This finding highlights the importance of strength and hypertrophy (muscle enlargening) resistance training for the older masters power athlete.

Speed, power and the masters athlete

While the factors contributing to the age-related reduction in maximal aerobic power have been widely researched in the masters athlete, studies examining maximal anaerobic performance in the masters athlete are still lacking. The muscle characteristics of a world champion masters power athlete (long and triple jump) were recently examined and compared with biopsy data obtained from previous studies of younger athletes. The results suggested smaller fibre areas for both slow and fast twitch fibre areas compared to younger athletes, despite high intensity sprint/jumps training 5 days per week for 8 years. Similar decreases in fibre size have also been observed in 60 plus year old power lifters compared to younger lifters and in our laboratory when we compared veteran sprinters fast twitch fibre size with those of younger sprinters.

A recent study examined the fibre areas of young (28 years) and old (68 years) non-athletes and compared them with masters swimmers (69 years), masters runners (70 years), and older (68 years) strength trained athletes. The average fibre area of the older swimmers and runners were similar to the age-matched non-athletes while the older strength-trained group had a mean fibre area identical to the young non-athletes. It would thus appear that strength training into old age may prevent the decrease in fibre size observed in older athletes. Thus, the good news is that slow twitch fibre enlargement may occur in the masters endurance runner and fast twitch fibre size may be maintained during aging in the masters power athlete through strength training.

Another study compared thigh muscle volume and vertical jump power in masters power and endurance athletes (40-78 years) with non-exercisers (22-67 years) and two groups of similarly-trained younger athletes (17-26 years). At age 75 years, it appeared that vertical jump power of the older athletes decreased with age to be about 50% of the value measured in the 20 year old athletes. Lean thigh muscle volume also progressively decreased in each of the groups after the age of 45 years. A significant finding was that peak anaerobic power decreased at the same rate in 20-45 year-old athletes when expressed per kg of thigh volume or per kg of body mass. However, between the ages of 45 and 75 years this difference was halved, strongly suggesting that muscle mass factors were involved in the age-related decline in anaerobic power observed in the older power and endurance athlete. This evidence is further supported by the findings of a 1988 study that suggested at least 50% of the reduction in VO2max of healthy untrained individuals 22-85 years could also be attributed to an age-related reduction in muscle mass. Again, I STRONGLY recommend that high intensity strength training in older athletes may prevent the age-related decrease in muscle mass observed in both masters endurance and power athletes, and lead therefore to improved sprint and possibly endurance performance.

To investigate this possibility and with funding from the Australian Sports Commission, we undertook an eight-week hypertrophy (muscle enlargening) strength training program on veteran male and female track sprinters. We observed significant gains in strength in both the males and females, some improving strength by over 150%. Thigh muscle size was increased in the males but not the females, probably due to the females lacking adequate testosterone, a hormone important for muscle growth. Most importantly, speed over 100 and 300 meters on the track was significantly improved in both the male and female veteran sprinters. This study highlights the importance of strength and hypertrophy resistance training for the older masters power athlete. I would suggest the older the athlete, the greater the importance should be placed on strength training.

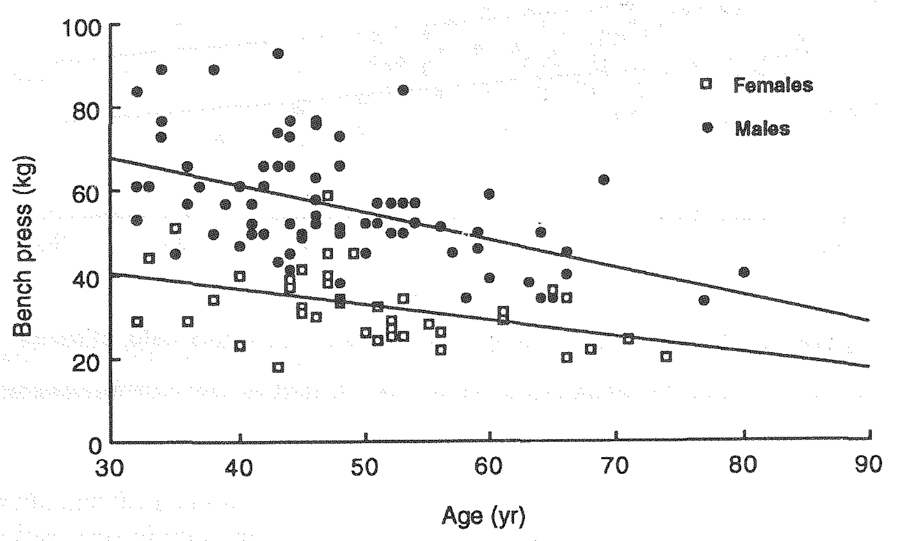


Figure 2. Upper body strength of masters track and field athletes

REASONS FOR DECLINES IN STRENGTH

Together with aerobic and anaerobic capacities, strength is generally recognized as a major component of successful sports performance, particularly in the speed and power sports such as sprinting, throwing, or jumping. Strength can be defined as the maximum force that can be exerted by a muscle group in one maximum effort. Strength is also vital to the maintenance of posture, maintenance of technique and injury prevention.

Strength and aging - very bad news!

Strength has been shown to decline with advancing age in both aging non-athletes and masters athletes. While numerous studies have shown strength decreases in aging non-athletes, we recently have observed significant decreases in both upper and lower body strength in veteran track and field athletes we examined at the 1991 Australian Masters Games (see Figures 2 and 3).

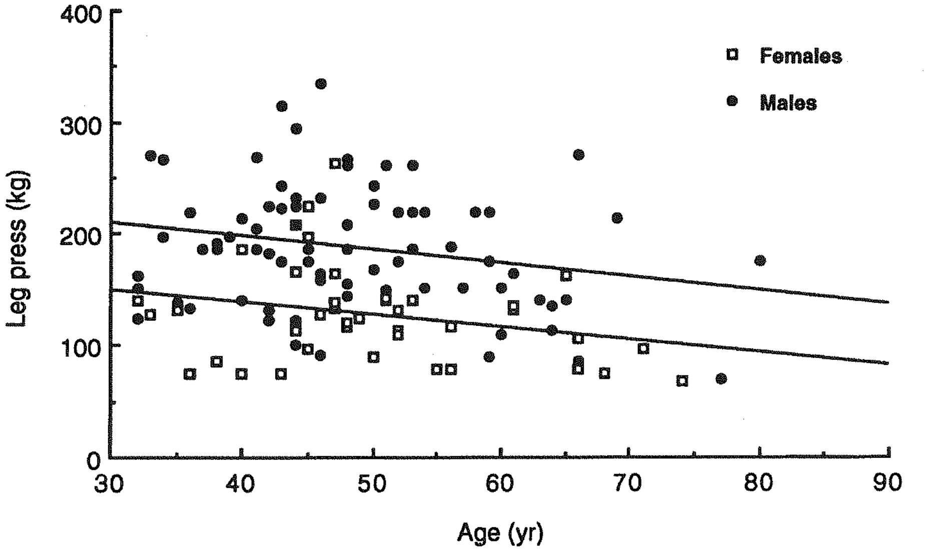


Figure 3. Lower body strength of masters track and field athletes

The strength of a muscle is influenced by a number of mechanical and physiological factors - muscle length, speed of muscle contraction, muscle size, muscle fibre type (slow or fast), and both nervous system and metabolic factors. Changes in any or all of these factors may explain the declines in strength observed in an aging population.

Limitations in the range of motion (flexibility) of different joints is frequently seen in older people. I see this in myself as I age with my toe-touching ability very quickly becoming my knee-touching ability. This decreased flexibility with age may be due to joint instability, disease, joint capsule (the tissue surrounding the joint) or ligament shortening, or loss of elasticity in muscles and tendons. Theoretically, these processes can affect strength because a shortened muscle will not produce as much force as a longer one. A recent Canadian study on veteran sprint runners observed decreased hip flexibility and suggested this may have lead to reduced force production and therefore reduced speed. A number of studies have also noted a gradual replacement of muscle tissue by connective tissue and fat in older non-athletes, which may also alter the elastic recoil component of muscles, a very important contributor to speed.

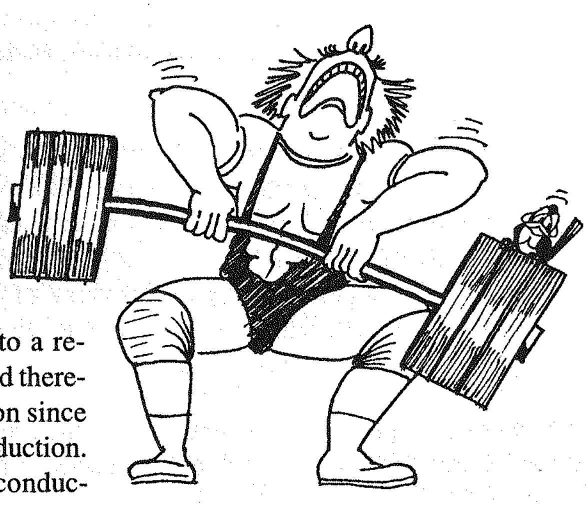
The size of a muscle is very important for strength development - just ask Arnold Schwarzenegger! Among the changes which occur with aging, the loss of muscle size has been observed most consistently and is thus a major contributor to the observed age-related reduction in strength. In an study of 959 participants in the

Baltimore Longitudinal Study, muscle mass was found to decrease gradually from the ages of 20 to 50 years and then to drop more markedly from ages 50 to 90 years. Indeed, men 80 years of age from this study exhibited a 40% lower muscle mass compared to men 30 years old. More recently, a 1988 study examined 83 men (28-87 years) and 101 women (22-82 years) and observed that the loss of muscle mass between 30 and 70 years was 23.4% for men and 22.0% for women and suggested this muscle mass loss to be a major contributor to the age-related decrease in aerobic capacity and strength of older non-athletes.

The age-related declines in muscle mass parallel the declines in strength seen in elderly, non-athletic men and women. A recent study examined the strength of both the elbow and knee muscles, fat-free mass and muscle mass in 200 healthy 45 to 78 year old men and women in order to examine the relationship between strength, age, and body composition. Fat-free mass, muscle mass, and strength were lower in the older (65-78 years) than the younger group (45-54 years). However, when strength was adjusted for muscle mass, the age-related differences in strength were not significant in all muscle groups. These results strongly suggest that muscle mass is a major determinant of the age-related differences in skeletal muscle strength and again emphasizes the need for hypertrophy (muscle enlargening) strength training in the aging athlete.

As noted earlier, this decrease in muscle mass may be the result of either a decrease in the size of single muscle fibres, a reduction in fibre number, or both. A number of studies have reported reduced fast twitch fibre area in both aging non-athletes and masters athletes compared to younger individuals. An age-related decrease in the area of fast twitch fibres may thus be a major contributor to decreased strength since these fibres produce greater strength than the slow twitch fibre.

Strength of muscles is determined by the size of muscles and also the nervous system that makes the muscles contract. A number of studies have shown extensive nervous system changes in skeletal muscles in aging people non-athletes. These changes could be due to impairment and / or loss of nerves in the spinal cord or a degeneration of muscle nerves. An age-related decline in the number of brain nerves has also been observed in rat studies. On the assumption that the same occurs in humans, this would lead to a reduction in nervous system drive and therefore a reduction in force production since the nerves affect muscle force production. With aging, decreases in nerve conduc-



tion velocity and muscle contraction time have also been observed, both of which may contribute to reductions in strength in older people.

The effect of strength training in aging non-athletes and masters athletes - we can do something about it!

Despite the decrease in strength in both older non-athletes and masters athletes, resistance (weight) training can result in significant increases in strength. Earlier studies that demonstrated significant gains in strength in older people suggested that the role of muscle enlargement was minimal and that the major contributing factors to increased strength were related to the nervous system. This arose from a study in 1980 that reported similar percentage increases (29.5 vs 22.6%) in strength in young (22 Years) and old (70 years) subjects after eight weeks of weight training. However, the same researchers observed that the major contributing factors to the observed strength increases were neural (nervous system) in the older individuals and hypertrophic (muscle enlargening) in the younger group.

A number of recent investigations have used more sophisticated methods (computerized tomography - CT) to examine the effects of high intensity strength training on muscles in older non-athletes. A 12 week strength training program increased strength by 5% per session in elderly (60-72 years) men with an increase in muscle area of 11.4% after the 12 weeks. This is similar to the increase in strength of 4.4 to 5.6% per session noted in young men and suggests that hypertrophy is possible in older people. Significant strength gains of up to an incredible 174% were observed in 90-plus year olds following an 8-week high intensity strength training program reported recently. The strength gain was accompanied by an increase in muscle size of 9%, suggesting that both muscle enlargement and nervous system factors contribute to strength gains in older previously inactive people who undertake high intensity resistance training programs. As noted earlier, we recently observed similar large (up to 150%) increases in both strength (males and females) and muscle size (males only) following 8 weeks of hypertrophy (muscle enlargening) resistance training with a group of 45-80 year old veteran sprint runners. More importantly, the athletes, many of them world class athletes, increased their sprint speed over 100 and 300 meters as a result of the program.

Thus, it appears that older people can show significant increases in strength in response to a resistance training program, due to changes in both nervous system and muscular factors. The available research suggests that muscle cross-sectional area increases following a high intensity resistance training program. The above studies strongly suggest at least partial reversal of the age-related decrease in the size of fast twitch fibres through strength training - again emphasizing the importance of strength training for the older athlete.

In recent studies on the good-old rat, the effects of a lifetime of strength training on aging skeletal muscle were examined. The results from these rat studies suggest that muscle force and muscle mass were maintained, at least until very old age, in strength-trained rats but not those endurance-trained. In a follow up study on humans, the same researchers examined muscle cross-sectional area (CSA) and maximal strength of the quadriceps in masters' swimmers, runners, and weight trainers. The factors measured were then compared with the values observed in both younger and older non-athletes. Both the strength and CSA of the strength-trained masters athletes were maintained at levels similar to those observed in the younger group. In contrast, the CSA and strength of the older swimmers and runners were similar to those of the older non-athletes and significantly lower than those observed in the younger group. The results of these studies again strongly suggest that strength training during aging may be able to prevent the age-related declines in strength and muscle mass commonly observed in both aging non-athletic and physically active people.

From the above discussion it is clear that the aging process affects almost all of the determinants of aerobic capacity, speed, and strength in both non-athletes and the masters athlete. However, the majority of available evidence suggests that aging people are capable of displaying significant improvements in strength, anaerobic, and aerobic capacities following training of high enough intensity. Regardless of whether the mechanisms are similar, the observed gains in strength and endurance are similar to those observed in a younger group when expressed as a percentage of the initial level.

It would also appear that masters athletes who maintain high intensity training into old age may prevent or lessen many of the declines in physiological functioning and muscle structure observed to occur in an aging non-athletes. Furthermore, lifetime athletes appear to show greater maintenance of physiological capacities than masters athletes who may have taken a break from training during their life. Finally, it appears conclusive that strength training is critical for the masters athlete wanting to maintain or prevent declines in performance.

BODY COMPOSITION AND AGING

The body can be broadly broken down into two separate compartments that are relevant to masters sport - fat mass and lean body mass. Lean body mass can be further broken down into the important muscle mass, bones, skin, and the organs such as the stomach, liver, brain etc.. Unfortunately the aging process for both males and females is one of a downhill slide in the area of body composition.
Total body weight appears to increase through to middle age and then declines from as early as 50 years. This loss of body weight has been attributed to loss of muscle mass, decreased total body water, loss of bone density, and replacement of muscle fibres by fat within the muscle itself, the lower density of which contributes to a lighter weight. This replacement of muscle by fat within a muscle is a common finding in older non-athletes. However, recently this phenomenon was shown by Scandinavian researchers not to occur in masters athletes who kept their muscle

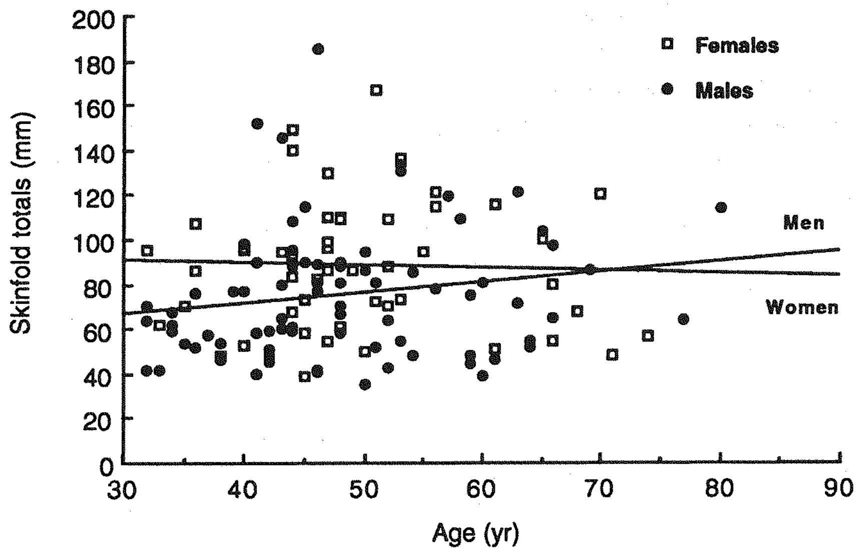


Figure 4. Skinfold totals of masters track and field athletes. Females (sum of 7). Males (sum of 8).

fibres stimulated through training.

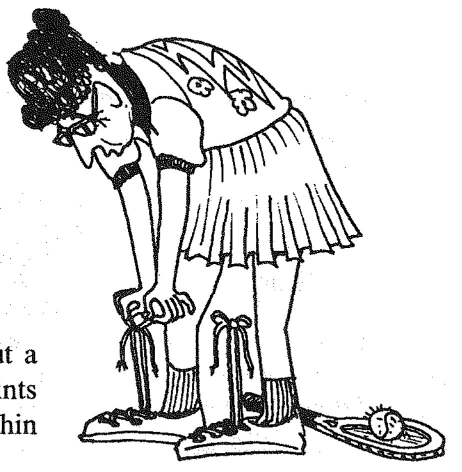
Lean body mass, in particular muscle mass, declines 6-8% per decade after the fourth decade of life - in both older non-exercisers and masters athletes. For all masters athletes whether sprint or endurance, this decrease in muscle mass will contribute greatly to decreased strength and speed and strongly suggests the need for strength training in the older athlete. Furthermore, this age-related decrease in muscle mass results in a reduced resting metabolic rate or the number of calories consumed at rest. A reduction in calorie intake is therefore suggested if total body weight is to be maintained into older age.

Apart from lean body mass, the other major component of the body is the amount of fat - 'aint that a horrible word. Fat mass or percent body fat has been shown to increase with age in older non-athletes. Furthermore, a trend has been observed towards an increase in fat stores around the internal organs rather than on the limbs, suggesting that fat stores below the skin are on the decline with age while internal fat is increasing. Interestingly, after the age of 40, non-exercising women increase in body fatness at a slower rate than men with each succeeding decade. In masters athletes, we recently undertook an examination of skinfold fat thicknesses in Australian veteran male (n=80) and female (n=49) track and field athletes. As can be seen from the graph above, female masters athletes appear not to increase skinfold thicknesses with age, whereas a trend towards a slight increase in skinfold thicknesses is suggested in male masters athletes, supporting the similar findings in older non-exercisers. So guys, pick up the act and exert some control over those eating habits!

A recent study from Canada examined 16 male endurance runners (66.6 ± 1.3yr) and compared their body composition to 24 non-athletes (67.9 ± 1.1yr). While no difference in total body weight or lean body mass was observed, a significant difference was observed in body fat with the masters athletes having a lower percent body fat than the non-athletes. This strongly suggests that aging people who train or exercise regularly can maintain lower body fat levels than similar-aged non-athletes. This has strong implications for prevention of cardiovascular disease since obesity is a major risk factor in heart disease, particularly in the older age groups.

My observations over many years of involvement in masters sports is that most masters athletes (including myself at the moment!) are carrying too much body fat. In endurance athletes, fat is just extra baggage we have to carry around the track, lowering our performance. In power athletes excess fat lowers our power to weight ratio and thus performance. It is therefore strongly recommended that masters athletes, in particular the males, maintain low skinfold scores and thus body fat. This is done through decreasing dietary intake and / or increasing exercise output.

A word of caution when and if you decide to get body fat measured. Body fat can be estimated from skinfold thicknesses. However, if you choose to have your skinfolds and / or body fat monitored, it is critical that the same person use the same method each time to determine these values. The variability between both body fat estimation methods and individual skinfold assessment methods is great. Indeed, differences in body fat on the same individual can range up to 10% depending on what method is used. Sports scientists currently use a skinfold total (mm) rather than percent body fat method. In general, a sum of nine skinfolds (biceps, triceps, subscapular - below shoulder blade, mid-axilla - armpit, iliac crest - above hip, supraspinale - between hip and belly button, abdominal - beside belly button, thigh, and calf measures) should total around 80-100mm in male masters athletes and 120-140mm in women masters athletes. However, as noted above, the lower the better. A sports scientist or sports dietician can greatly assist in both measurement of skinfolds and strategies to reduce them if required.



FLEXIBILITY AND AGING

Flexibility is the range of motion about a joint. Flexibility requirements of specific joints are specific to each sport and even to events within those sports. For example, a freestyle swimmer may need good shoulder and ankle flexibility but a breast-stroke swimmer requires good hip, knee, and ankle mobility. Flexibility decreases with age and may be due to joint instability, disease, joint capsule (the connective tissue surrounding the joint) or ligament shortening, or loss of elasticity in muscles and tendons. Theoretically, this decreased flexibility can reduce muscle force output and thus strength, power and speed.

As noted earlier in the strength section, a recent study of veteran sprint runners in Canada demonstrated that both decreased hip flexibility and lower limb strength were major reasons for decreased stride length and slower times as sprint runners aged. This finding strongly suggests that to help maintain length of stride or stroke (in the swimmer), the masters athlete should incorporate joint specific flexibility training into their program. While many of us will use stretching exercises as part of our warm-up and cool-down procedures, from my experience few masters athletes will program flexibility training as an important training method in its own right. This can be done in front of the TV while watching the news or favourite sports show.

While the masters athlete may demonstrate reduced flexibility relative to younger athletes, a recent Dutch study suggests that flexibility of the masters athlete is greater than similarly-aged non-athletes. These researchers measured hip and shoulder flexibility in three groups of 55-85 year old men and women - a "least active" group, a "moderately active" group, and a "most active" group. The least active group had significantly reduced hip and shoulder flexibility compared to the other two groups. This finding suggests that physical training into older age can benefit flexibility.

I strongly recommended that masters athletes who are injury prone (possibly through joint tightness), those who need long strides (sprint runners) or strokes (all swimmers), or those who need flexibility for range of motion reasons (eg. divers, tennis players), should incorporate flexibility training into their schedule, and not just as a part of warm-up. Consult a sports physiotherapist or one of the books below for guidance in this area.

RECOMMENDED READING

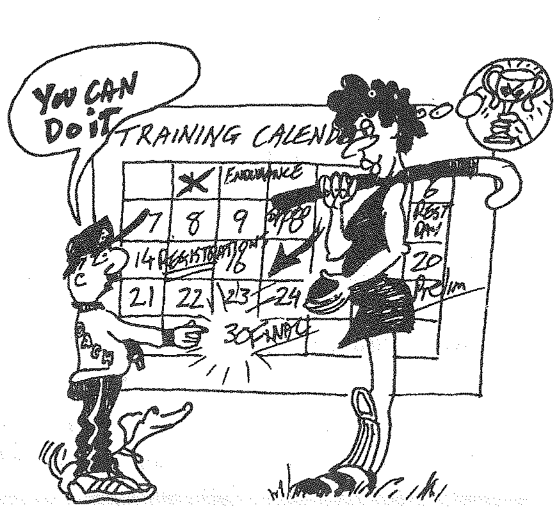
1. Alter, M.J. (1988) ***The Science of Stretching***. Human Kinetics, USA. ISBN number: 0-87322-090-0. Available from Human Kinetics, PO Box 80, Kingswood, SA 5062. Cost: $35-45.
2. Anderson, B. (1980). ***Stretching***. Shelter Publications, USA. ISBN number: 0-936070-01-3. Available from Stretching International, PO Box 133, North Balwyn, Vic 3104. Cost: $25-35
3. Killmier, A. (Ed.) (1992) ***Mastering Swimming: A self-help guide for coaches and swimmers.*** Fraser publications, Victoria. ISBN number: 0-9588384-6-1. Available from Fraser publications, PO Box 1045, Ivanhoe, Vic. 3079. Cost: $25-30.
4. Kerlan, R.K. (Ed). (1991) ***Sports Medicine in the Older Athlete.*** Clinics in Sports Medicine Series. WB Saunders, USA. ISBN 0278-5919. Cost: $60-70.
5. Sutton, J.R. & Brock, R.M. (Eds) ***Sports Medicine for the Mature Athlete.*** Benchmark Press, USA. ISBN number: 0-936157-04-6. Cost: $70-80.

CHAPTER 2
PLANNING THE TRAINING PROGRAM

Now that we have an appreciation of the factors that may explain a decline in performance as we age, the important question is how can we prevent that slowing down process. Regardless of whether we are 20 years old or going on 100, a lifetime masters athlete or novice, there are certain training principles to which athletes need to adhere when planning their training program.

The most important principle is **SPECIFICITY**. That is, the masters athlete should analyse the needs of the chosen sport or event and specifically train for those demands. A sprinter should do sprint and resistance training, an endurance athlete should focus on endurance training. I see too many masters athletes train for speed events in competition by endurance training methods. While endurance training methods are great for health reasons (weight control and heart disease prevention) and as a base for speed work, the masters athlete will find they will lose speed by continually training with long, slow distance. It is critical that the competitive masters athlete prepare through training for the exact stresses competition will place on the body.

The second most important principle for the masters athlete is **PROGRESSIVE OVERLOAD**. That is, gradually training harder, more often, or for longer in a session. If you specifically require endurance, you should progressively increase how long or how hard you train. If you are a sprinter, you can progressively increase how hard you do your speed work. Generally the harder we train, the longer the recoveries should be. Gradually training harder, more often, or for longer will allow your body to adapt slowly and prevent injuries or overtraining.



It has been well documented that masters athletes train with lower volumes and lower relative intensities than younger athletes, possibly due to lack of motivation or time as a result of family or work commitments. However, it might be suggested much of the observed decrease in masters athletes speed and endurance might be explained by decreased training intensity or volume relative to younger athletes.

This may be due to the reasons outlined above or to the myth that the older person shouldn't train hard for cardiovascular or injury risk reasons. I am totally opposed to this attitude - an attitude I see all too often in both the general community and the medical profession. I see no reason why the masters athlete cannot train as hard as the youngsters - on the assumption that the masters athlete is healthy and has been pre-screened by a sports physician and / or sports physiotherapist.

The more experienced masters athletes will have no problems with the principle of progressive overload. However, many masters athletes will be competing for the first time in many years. The more experienced and specifically fit we are, the more quickly we will adapt to our training. Those of us who are "making a comeback" or competing for the first time in years must realise that the principle of progression is even more important - start easy, and gradually build the intensity, frequency, and volume of your training.

Another important principle of training is **RECOVERY-ADAPTATION**. This principle involves working hard at times and easy at times. We work hard at times to stress our body and we work easy at times to allow recovery from the stress. This is the concept of periodisation and involves breaking up your training season into short blocks of time (eg. one week), longer blocks of time (eg. three-six weeks), and longer blocks - the season. It is generally acknowledged that within a week we work hard at times and easy at times - the old hard / easy principle. Within a three week block we might have a hard week, a medium week, and an easy week. During the season, we generally lift intensity from three-week block to three-week block.

Find below a suggested table for the masters athlete planning speed development:

SPEED DEVELOPMENT

May - June	• Strength/hypertrophy (muscle enlargening) in the gym • Drills and some speed • Plyometrics - bounding, jumping • Aerobic endurance
July - Mid August	• Speed endurance • Increased intensity of sprints • Plyometrics • Strength maintenance in gym • Some speed
Mid August - September	• Maximum speed • Active Recovery • Speed Endurance • Plyometrics

The importance of gradually building the volume of intense training and allowing time to adapt to this increased stress cannot be emphasised enough . Not enough athletes use recovery as an important component of training. Recovery can include spas, massages, light swims, or recovery jogs. Use these methods, particularly when tired. For the older athlete, two maximal speed or power workouts at the most are suggested in a hard week. Although no research has examined recovery between workouts in the older athlete, anecdotal evidence from numerous older athletes I have spoken to suggests we take longer to recover between intense training sessions. Generally maximal speed work should be done when fully recovered, so take the long recoveries between hard workouts.

Find below a plan for the endurance masters athlete:

ENDURANCE DEVELOPMENT

January - March	• Strength / hypertrophy in gym • Aerobic endurance base
April - May	• Maintain base and gym work • Introduce transition training (intervals, hard runs)
June - July	• Maintain base and transition training • Speed and taper

Again, the masters endurance athlete needs to work on the easy - medium - hard principle from week to week and the hard - easy principle during a week. If the emphasis is on building mileage during the May - June period (eg. cycle road racer), then hard is long easy miles, medium is shorter easy miles, and easy shorter again. During the next three week block a hard week might be one long ride, two strong rides, and one aerobic interval session with the medium week being two easy longer rides, one strong ride and one aerobic interval session. We can thus manipulate intensity and duration, depending on the demands of our event and what phase of training we are in, and whether we are in a hard, medium, or easy week.

Another important principle in planning your program is **VARIETY**. Variety in training intensity, workout structure, venue, type of training etc. all provide that break from the routine we all need at times to prevent staleness. While I usually run and swim train separately, I occasionally enjoy throwing on my "bum" pack with goggles and chamois and running to the pool hard, have an easy swim, then run as I feel on the way home.

INJURY PREVENTION is also a critical principle of training, particularly for those athletes returning to competition after not having competed or trained for an extended period of time. A number of factors need to be considered in preventing injury. These include your previous injury history, common injury sites in your sport / event / position, your technique (good or bad), and whether you progressively overload your training. I strongly recommend that masters athletes, particularly those inexperienced, visit a sports physiotherapist who understands your sport. Ask them for a musculoskeletal profile after telling them your history and what sports and events you are training for. For the power athletes I also strongly recommend strength training under a suitably qualified person (Australian Strength and Conditioning Association (ASCA) or appropriate degree). In addition, I also suggest that a coach be used to oversee technique, particularly for those involved in power or endurance events.

Finally, the most important principle of all is **LISTEN TO YOUR BODY**. We as masters athletes are experienced enough to know when it's time to ease back on how hard or often we train. If the body is "creaking", "niggling", or tired, ease back or rest completely. If the "bod" continues to complain, see a sports medicine-trained professional who understands your sport.

In summary, as masters athletes we must gradually lift intensity, frequency and/ or duration of training depending on what event / sport / position we are training for. We must work hard at times to stress our body and train easy or rest at times to allow our bodies to adapt to the hard work. The longer we have been away from training the greater the need to follow these principles. By specific training and listening to our bodies as we train progressively harder, we can hopefully achieve our own personal goals.

RECOMMENDED READING

1. Bompa, T. (1994). ***Theory and Methodology of Training*** (3rd Edn) Kendall/Hunt, USA. ISBN number: 0-8403-9061-0. Cost: $40-50.
2. Dick, F.W. (1989) ***Sports Training Principles***. A & C Black, London. ISBN number: 0-7136-5644-1. Cost: $40-50.

CHAPTER 3
ENDURANCE AND THE MASTERS ATHLETE

The aging process is characterized by a steady decline in endurance performance (see Figure 5 below). While this decline appears inevitable with age, the rate of decline in the aerobic capacity of the masters athlete is approximately half that observed in non-exercising older people. The question then becomes - what can we do to slow this decline in endurance performance? To fully understand how we can reduce this decline, we need to understand the factors that affect endurance capacity.

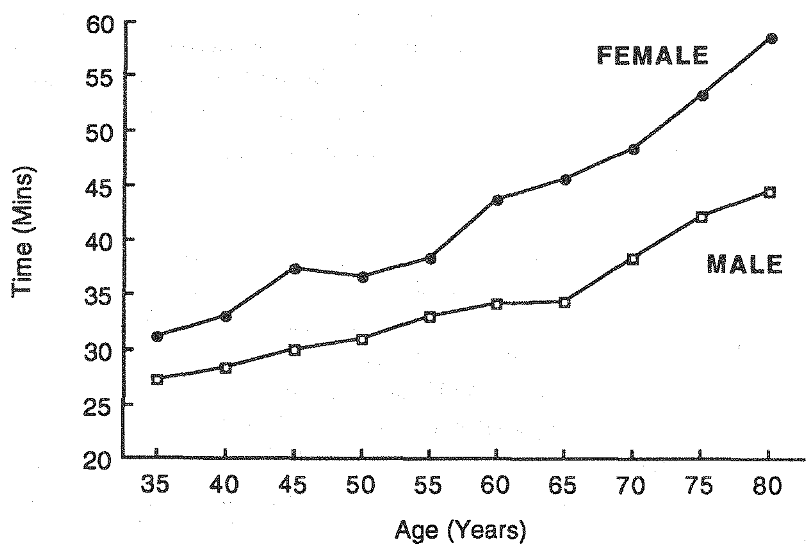


Figure 5. Male and female 10,000m world records as at March, 1994

FACTORS INFLUENCING ENDURANCE

Five factors determine our abilities to be good endurance athletes. These include genetics, gender, body composition, age, and training. Firstly, it has been estimated through studies on identical twins that 70-75% of endurance ability is genetic. That is, our parents have given us (or forgotten to give us!) the ability to be an endurance athlete. Our parents have given us a particular body type, a possible endurance physiology, a high or low percent of slow twitch endurance muscle fibres, the ability to recover from or adapt to training stress, and the mental constitution for endurance. If we don't have these factors in our favour, we are going to find it difficult to perform in endurance events.

The second factor is gender. Female athletes, regardless of age and training, generally have a 10% lower aerobic capacity or VO2max than male endurance athletes. This is due to the fact that females have smaller hearts (therefore pumping less blood and oxygen), a smaller concentration of haemoglobin (substance in the blood that carries oxygen), and carry greater amounts of body fat than men. While it might be argued that extra fat may lead to better flotation in female distance swimmers or a better energy supply in female ultraendurance athletes, it is generally agreed that the extra fat found in most females is a hindrance to endurance performance when compared to males.

Thirdly, body composition (fat mass versus lean (fat-free) body mass) is very important to the endurance athlete. Aerobic capacity (VO2max) is expressed initially as litres of oxygen per minute (L/min) when measured in a laboratory. It is then divided by body weight to get ml/kg/min units. It is therefore to the masters endurance athlete's advantage to be as lean as possible and have the kilograms available to be useful (muscle, bone etc) and not wasted (fat). No endurance athlete wants to carry extra "bricks" around on a bike, running track, playing field or through the water.

As noted in the previous chapter, age is a critical factor influencing VO2max. Aerobic capacity or VO2max declines in sedentary (non-exercisers) aging people at approximately 1% per year, in older athletes at 0.5% per year. VO2max is defined as the maximal volume of oxygen that can be transported to, and consumed by the working tissues. To understand why VO2max declines with age, we need to remember the factors that physiologically determine VO2max - maximal heart rate and maximal stroke volume (amount of blood pumped per heartbeat), and maximal arterio-venous oxygen difference (amount of blood extracted from the arteries by the working tissues).

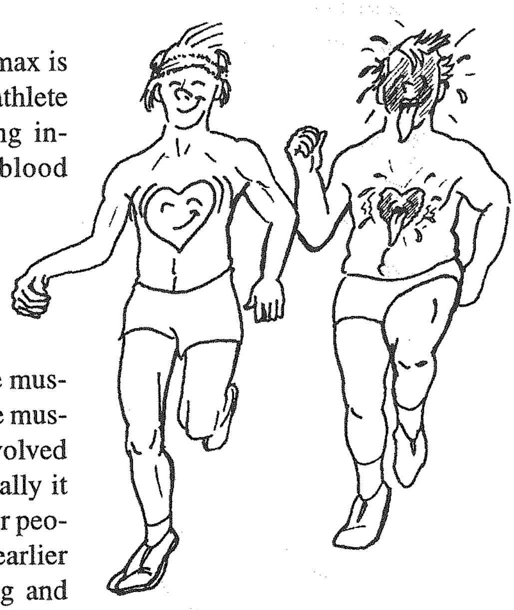
As noted in the first chapter, maximal heart rate (MHR) declines with age in males and females at the rate of one beat per year theoretically with maximal heart rate determined according to the books by 220-age (ie a 50 yr-old has a maximal heart rate of 220-50=170). While this formula is adequate for the non-athlete, I strongly suggested that the competitive masters athlete have their individual maximum heart rates determined in the laboratory by a sports physiologist or sports medicine specialist. My experience with testing hundreds of masters athletes is that this formula works for only 5-10% of masters athletes. Another method recommended for the healthy, non-at-risk, well-motivated, and experienced masters athlete is to determine their own MHR. This can be done by doing a 10-15 minute continuous test where intensity (speed, gearing, stroke rate, blade pressure etc.) is lifted each minute to exhaustion. This test should be done after a strong warm-up, should be followed by an extensive cool-down, and always done with a heart rate monitor on and a partner around. Importantly, MHR generally differs within an individual depending on what sport or event is undertaken. For example, a 50 year-old masters triathlete may have a MHR (beats per minute) in running of 180, in cycling 175, and in swimming freestyle 167, or swimming butterfly 176. MHR is largely dependent on both the amount of muscle mass and body position used in the sport or event.

The second factor contributing to an age-related decrease in VO2max is an age-related decline in maximal stroke volume (SV) or maximal volume of blood that is pumped per beat of the heart. It is generally around 70 ml but can get as high as 100ml in highly-trained masters endurance athletes. While SV declines in older non-athletes, it appears not to decline in masters athletes.

Finally, an age-related decrease in maximal arterio-venous oxygen difference (A-VO2) (the amount of oxygen extracted from the blood by the working tissues) may lead to decreases in VO2max in the masters athlete. While A-VO2 declines in older non-athletes, it appears not to decline greatly in masters athletes. Thus, the major, and unfortunately theoretically untrainable factor explaining a decrease in aerobic capacity in older athletes is an age-related decrease in maximal heart rate.

The age-related decline in maximal aerobic capacity in older non-exercisers has also been linked to decreases in muscle mass - the most common observation in a non-exercising aging population. My PhD research also observed a decrease in muscle mass (and strength) in older versus younger endurance runners. This would strongly suggest the need for hypertrophy (muscle enlargening) resistance training during the pre-season in the older endurance athlete, particularly those in middle distance type events. See a strength specialist at your gym for professional advice in this area.

The final factor influencing VO2max is training and this is where the masters athlete can do something. Endurance training increases stroke volume and thus the blood pumping capacity of the heart. Importantly, endurance training also increases maximal arterio-venous oxygen difference by increasing blood volume, increasing the number of capillaries (blood vessels) around the muscle fibres doing the work, and raising the muscle concentration of all the chemicals involved in aerobic energy production. Historically it was thought that aerobic capacity in older people was untrainable. However, those earlier studies used very low intensity training and

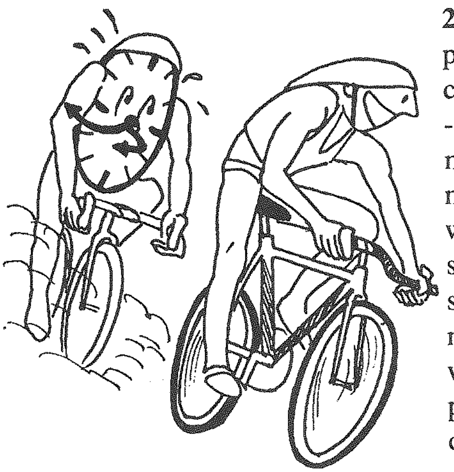


did not stress the aging people involved. The good news for us older endurance athletes is that it has now conclusively been shown that older people undertaking endurance training show similar percentage increases in aerobic capacity and performance as younger people.

FACTORS RELATED TO SUCCESSFUL ENDURANCE PERFORMANCE

Now that we have an understanding of the factors that determine endurance capacity and how these are affected by aging, we might think that VO2max is the most critical factor in endurance performance. Wrong! While it is important, it is not the most critical factor when it comes to performance on the track, road, lake or pool. We will now examine these other factors after a brief discussion of VO2max.

1) **Maximal Oxygen Uptake (VO2max)** is the greatest rate at which oxygen can be consumed by an athlete. The units of this capacity are ml/kg/min and values of some outstanding younger athletes are (were): Said Aouita (5000m runner) - 83.0; John Walker (miler) - 82.0; Seb Coe (miler) - 77.0; Greta Waitz (female marathon) - 73.5; Peter Snell (miler) - 72.3; Derek Clayton (marathon) - 69.7. Values in male 60-plus year-old elite runners and cyclists are 50-55 ml/kg/min. Swimmers usually have a lower capacity due to the smaller muscle mass involved that can therefore take up less oxygen. VO2 increases as running, swimming, or cycling speed increase. It is therefore believed that a high VO2max is a good predictor of endurance performance. While this capacity is important, a far better predictor of endurance performance is what fraction or percentage of that aerobic capacity can be maintained for the duration of an event - a concept called the anaerobic threshold.



2) **Anaerobic threshold.** This is the percentage of the athletes aerobic capacity that can be used at race pace - the "hurt but hold" intensity. Top marathoners and road cyclists can maintain 80-90% of their capacity while slower athletes can only sustain 75% of their capacity for the same distance. Above this pace the muscles start to produce lactic acid which upsets the muscle contraction process and slows the breakdown of carbohydrate so that energy produc-

tion is compromised. In a later section I will discuss ways to measure the anaerobic threshold and ways to help raise it so that we can race harder and not produce lactic acid.

3) **Fatigue resistance** is the ability of a masters athlete to maintain pace during prolonged endurance exercise. A major adaptation to longer duration endurance training is fatigue resistance. The long slow distance and "miles in the arms or legs" concept allows us to resist fatigue. Interestingly, a recent study from South Africa has shown that black endurance runners have superior resistance to fatigue than white runners.

4) **Economy of motion** is the oxygen cost required to maintain a specific speed. Elite masters endurance athletes, through better technique, use up to 15% less oxygen to maintain a pace than recreational masters athletes. Technique is critical in improving economy with runners ideally having a relaxed upper body or cyclists not throwing their upper body around - both these activities using up valuable fuel and oxygen but not producing speed. The longer, slower runs, cycles, swims, rows achieve gains in efficiency.

5) **Fuel usage.** At high speeds there is a greater reliance on carbohydrate than fats as a fuel for energy production. However, well-trained masters athletes can make greater use of fats as a fuel during racing than less-trained athletes, thereby conserving valuable liver and muscle carbohydrate (glycogen) stores.

Through the correct training intensities and durations, we can adapt our physiologies to maximize each of these above factors.

TRAINING TECHNIQUES FOR SUCCESSFUL ENDURANCE PERFORMANCE

Since the 1950's a number of influential coaches (Franz Stampfl, Percy Cerutty, Arthur Lydiard in running), (Forbes Carlile and Jim Councilman in swimming), (and Eddie Boryseqicz in cycling) have changed training methods in their sports. A common practice of many coaches and athletes is to adopt the prevailing training methods of current world class athletes in their sports. This approach has not only lead to many a good athlete burning out but also has lead to a be-

lief that more is better and an emphasis on "big mileage" being seen as the key to successful endurance performance. In a recent study on young swimmers, well-respected sports scientist and masters athlete David Costill halved the volume of training being undertaken by a swim squad and found no change in swim performance compared to a squad who maintained twice the volume. This research strongly argues against the belief that more is better. Indeed, the prevailing training research recommends a combination of both quantity and quality as the keys to endurance performance.

Endurance training intensities

Due to the relationship between training intensity and heart rate being linear (a straight line), we can use heart rates as a means of determining training intensity. The intensities we will use are based on the masters athlete knowing their own maximal heart rates for their chosen sport(s). As noted earlier, it is important to understand that maximal heart rate (and VO2max) even within an individual athlete is invariably different for swimming, cycling, running, rowing etc. due to the different muscle masses being used and the different body positions involved with each sport.

While it is strongly recommended that maximal heart rate in the masters athlete be determined within a laboratory and in the presence of a sports medicine practitioner, the experienced and healthy masters athlete may decide to determine maximal heart rate themselves. As stated earlier, this can be done by warming up well, then doing 10 continuous one minute increases in intensity starting easy then gradually building till the last minute is flat out. The test should be done with a heart rate monitor on and be followed by a 10-15 minute warm down.

Once determined, the following table can be used to establish heart rate training zones:

ZONE	NAME	INTENSITY
1	Recovery	< 65% Max HR
2	Aerobic	65-75% Max HR
3	Extensive Endurance	75-80% Max HR
4	Intensive Endurance	80-85% Max HR
5	Anaerobic Threshold	85-90% Max HR
6	Maximal Aerobic	> 90% Max HR

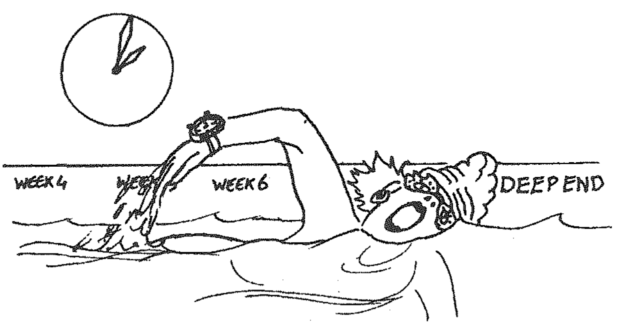
These heart rate zones are scientifically-based guidelines but are exactly that - guidelines. I hear too many stories of masters athletes becoming slaves to a heart rate monitor or a heart rate that they saw in one of the many heart rate training books available. Many of these books assume each person has a maximum heart rate of 220-age, or that the level 2 training zone can be determined by taking your age from 180. The only real way to determine your maximal heart rate is in a laboratory or using the incremental test referred to above.

When using these heart rate zones and a heart rate monitor, it is also important to remember that heart rates will elevate when exercising in the heat. This is due to the fact that when you train in the heat, you may dehydrate slightly through sweat loss. This lowers your blood volume which results in the heart having to pump more quickly and harder to get the same amount of blood and oxygen to the working muscles. Secondly, when training in the heat, blood is diverted to the skin to help offload the heat generated in the muscles. Again, the heart has to work harder to keep the amount of blood pumping to the muscles to give them the oxygen they require to maintain speed.

I can vividly recall being in Townsville at Christmas time and going for an easy run with a 50 year-old triathlete one hot and humid Sunday morning. His coach had told him to maintain a heart rate of 126 per minute for his long runs. He was finding that he was walking at the end of his run to maintain 126. I asked him to wear his heart rate monitor but to reverse his watch that gave the heart rate readout. We started at a heart rate of 128 and after 90 minutes of running at the same pace I asked him to have a look at his heart rate - it was 148. Heart rate drifts upwards on long training bouts, particularly in the heat. Indeed, research suggests that heart rates during submaximal work increase by 1.4% for each degree above 21 degrees Celsius. For example, at a constant pace, a heart rate of 140 at 21 degrees will become 160 at 31 degrees.

Bearing these considerations in mind, let us now discuss each of these training zones individually.

Level 1 is recovery and can be done using the sport we are training for or some other method such as water running or swimming. The important factor here is that intensity is low and duration short. This type of "training" is



useful after racing, after hard training sessions such as those in levels 5 or 6, or when the body tells you it's time for a rest.

Level 2 is the minimum intensity required to give an endurance training response. The beginning masters endurance athlete might start out at 65% of MHR but as fitness improves or the years accumulate, the intensity required to gain adaptations will increase. The adaptations that occur with this training include:

- *increased stroke volume (amount of blood pumped per heartbeat)*
- *increased oxygen transport in the blood*
- *increased blood volume*
- *enhancement of the muscles to use oxygen*
- *increased capillary density within the trained muscles*
- *improved mobilisation and use of fat as a fuel.*

This type of training, together with level 3 extensive endurance training, forms the base of endurance training and should be performed for a minimum of 30 minutes up to 2 hours plus depending on the event being trained for. The masters athlete should aim for a minimum frequency of 3 times per week with up to 10-12 sessions per week for the more competitive and experienced masters athlete.

Level 3 training is done at 75-80% of maximal heart rate for long periods (hence extensive). Examples are 10-30k runs, 40-120k rides, 5-15k rows, or 1500-3000m swims or longer sets of intervals. This type of training takes place during the base training phase and induces similar adaptations as those noted above for level 2 training.

Level 4 training is done just below anaerobic threshold and because intensity is lifted, duration is reduced. Examples are 5-20k runs, 30-80k rides, 5-10k rows, or more intense intervals in the pool. Importantly, the intensity is just below "hurt but hold" anaerobic threshold intensity and is thus "strong but comfortable". This type of training raises both VO2max and anaerobic threshold, as well as improving the economy of an athlete.

It is difficult to understand how training at large volumes below planned race pace can possibly prepare the masters athlete for racing. It is thus important to undertake some training at anaerobic threshold.

Level 5. This type of training has the objective of exposing the body to sustained exercise corresponding to the masters athlete's highest current steady state pace. The experienced masters athlete can therefore determine the pace for these longer workouts or intervals by calculating current time trial pace minus 5% or doing a 30-minute time trial at steady state (no sprint at the end) and observing the heart rate at the end of the time trial. In general, this intensity can be described as the "hurt but hold" intensity. The adaptations that take place with this type of training are:

- *elevation of VO2max*
- *raising of the anaerobic threshold*
- *increased removal of lactic acid*
- *decreased production of lactic acid*
- *specific nervous system patterning of the muscle fibres needed during racing*

The intensity of training is elevated to 85-90% of maximal heart rate and can be done through either continuous work of at least 20 minutes duration but no longer than 60-90 minutes (eg. 5-20k runs; 20-60k rides; 1500m swims) or interval (eg. 10-15 x 100m swims; 15-20 x 1k cycles; 10 x 400m runs) training with short recoveries that are half or less of the work time. Importantly with endurance training intervals, the quality of the last interval should be as good as the quality of the first interval. This type of training should be performed at the most 2-3 times per week, should be preceded by a good warm-up, followed by a good warm-down, and generally followed by an easier day.

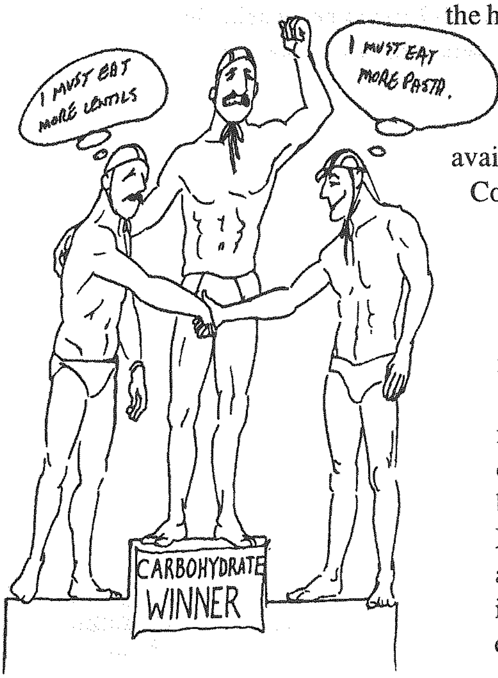
During anaerobic threshold training periods, recovery is critical and base training intensities (levels 1-2) should not be forgotten. Recovery can also be enhanced by eating or drinking carbohydrate-rich foods since both level 5 and 6 training mainly use muscle and liver carbohydrate as their energy source and supplies will be depleted after such training. The carbohydrates should have a high glycemic index (see Nutrition section) and be consumed ideally within the first 30 minutes after training but critically within the two hours after training.

Level 6 or maximal aerobic training employs intervals with speeds that are greater than planned race pace but with long recoveries. The overall training volume is reduced during this final phase which lasts 4-6 weeks but the intensity is lifted. Again, as with the transition training phase, recovery is critical and levels 2-5 training intensities should not be forgotten during this phase. Examples of this type of training are 3-8 minute (300-400m swims; 5k reps on the bike; 1k reps on the run track) repeats with 3-8 minute active (easy swim, spinning or jog) recoveries. Intensity is 90-100% of maximal heart rate for each interval but recovery intensity is down to 60-70% of maximal heart rate. The masters athlete should be well warmed up and build into the first 30 seconds of each interval. Repetitions depend on individual tolerances but 4-10 reps would be suggested depending on the individual athlete, their training age (years of training), fitness level, predisposition to injury, and whether you swim, bike or run which have an increasing "tear-down" factor. At the most, two sessions of Level 6 per week should be used with easy recovery work in between. Adaptations that take place with this type of training include:

- *increased tolerance to lactic acid*
- *elevated VO2max*
- *improved endurance speed*

Determination of anaerobic threshold

As you may have gathered from the earlier discussion, anaerobic threshold training is critical for strong performances in endurance events. While determining this intensity can be done using 85-90% of maximal heart rate, you need to know your maximal heart rate. If you are a triathlete, you will need to know your maximal heart rate for swim, bike and run - they are usually different with running generally the highest, cycling approximately 10 beats per minute lower, and swimming the lowest at 10-20 beats lower than running. Other methods that are available to you are to do a lactate curve, a Conconi test, or a time trial.



A lactate curve is usually done in a sports science laboratory under the supervision of a sports physician. It involves working progressively harder (running faster, pushing bigger gears, increasing time per 500m on a rowing ergometer) every four minutes while blood is taken and heart rates recorded. Lactate is produced in relatively large amounts when the muscles begin working anaerobically (in the abscence of enough oxygen). Once produced in the muscles, the lactate moves into the blood where it is removed via the heart, liver, and other muscles. When the concentration of lactate rises dramatically in the blood, scientists have suggested the athlete is at anaerobic threshold. Because we know the speed, gearing, or time per 500m at which lactate began to rise, we can determine the heart rate at which anaerobic threshold occurred. While it the most valid method for threshold determination, it requires sports scientists and quite expensive equipment.

The Conconi method for anaerobic threshold determination was developed by an Italian sports scientist named Conconi who worked with former world one-hour cycling champion, Moser. The principle of this test is that work rate (speed, power) is increased every 30-60 seconds and heart rate recorded at the end of that period using a heart rate monitor. You then plot a graph of speed against heart rate. Conconi believes that heart rate increases in a straight line until a particular speed (anaerobic threshold) at which the line curves downwards. My experience with this method is that it works with some athletes but not with most. However, the beauty of the test is its simplicity - all you need is a heart rate monitor and a pen and paper. You can contact the suppliers of Polar Heart Rate Monitors for more details on the test.

The final possible method for determining anaerobic threshold is doing a time trial. This should be done over at least 30 minutes on an uninterrupted course (pool early on a Saturday, windtrainer, rowing ergometer, or run track) and at a steady state pace with no sprint at the end. The aim is to self-select a pace you can maintain continuously for the time trial with no sprints or change in pace. The heart rate at the end is going to be very close to your anaerobic threshold. The beauty of this test is again its simplicity. However, my experience is that this test is most useful for experienced athletes who know how to hold pace well.

Now that we have examined the different endurance training intensities, we need to make decisions on how we put these training intensities together - the concept of periodization.

Periodization of endurance training

The art of training correctly is putting these training intensities together during a week (microcycle), during a 3-4 week block (mesocycle), or throughout the season (macrocycle) to maximize training time and prevent overtraining. Hard, medium, and easy days, weeks or 3-4 week blocks are manipulated to stress the body at times and then to allow the body to adapt to that stress.

A microcycle of a week might consist of six training sessions with a day off but with two periods of easy, medium, hard days. During the base development or preparation phase where we are getting the "miles in the legs" or "kms into the arms", the terms easy, medium and hard might be distances covered getting longer or intensity levels 2-4 being manipulated and distances held constant. During the specific preparation or mid-season phase, the same easy, medium, hard schedule might be in place, but hard might be level 6, medium level 4, and easy level 2.

A mesocycle for endurance might be a 3-4 week period where a hard week is followed by an easy week, then a medium week. Again assuming six sessions a week, a hard week mid-season might be 2 x level 2-3, 1 x level 4, 1 x level 5, and 1 x level 6 with an easy week being 1 x level 6, 1 x level 1, 3 x level 2, 1 x level 5. Remember the objective of each phase but as a rule of thumb increase volume through early season phase, lift intensity and drop volume during mid-season, and do the same during the competition phase.

The endurance training year can be broken up into three main phases - the base or foundation phase, the transition phase, and the speed / power training phase.

1) **Base / foundation training** is performed during the non-competitive period of the training year and builds the aerobic base on which more intense training is built. Levels 2-4 are emphasized with kilometers gradually built up. This phase may last up to 12-16 weeks depending on the time lag between the competitor's last competitive phase and the experience of the athlete.

2) **Transition training** or mid-season training can last 6-8 weeks and is done by introducing levels 4-5. Recovery between level 5 sessions is important so as to allow quality work to be done during those sessions. Volume (kms) drops but intensity is lifted during this phase. Races should be entered and considered to be level 5 training.

3) **Speed and power phase** is undertaken in the last 4-6 weeks where, although all other levels are maintained, level 6 work is introduced to give endurance speed to the masters athlete. Volumes are reduced as a result of the intensity being high.

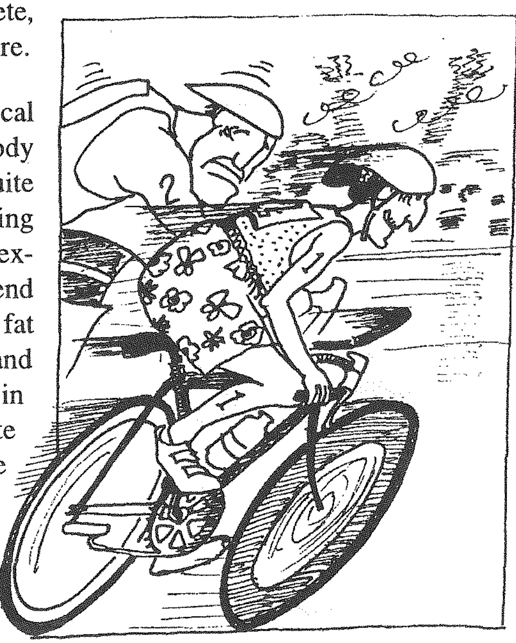
   The transition and speed / power phases are where injuries may occur since intensities are so high. Listening to the body during these phases is essential and recovery methods should be used extensively. Importantly, both threshold and maximal aerobic power training is difficult and should only be undertaken by healthy masters who have no cardiac risk factors, a training age of 2-3 years, are not prone to overuse injuries, and who have undertaken an extensive foundation phase.

   However, I see no reason why the masters athlete cannot train as relatively intensely as the younger athlete. The only differences I see is that the training pace will be relatively slower (generally!) and that the number of intense sessions in a 7-10 day period may be reduced. This is due to the anecdotal evidence that masters athletes take longer to recover from the intense sessions than the younger athlete. As a general rule, when doing quality work (levels 5-6), be fresh - quality counts!

4) **Tapering or peaking** is a highly individual matter but usually takes place during the last 7-10 days prior to major competition and involves a gradual or dramatic reduction in training volume (kms) and frequency. Intensity should be maintained. Indeed, a recent study found that middle distance runners significantly improved their performance times by sharply reducing their training volume while maintaining or increasing their training intensity seven days before a race. This taper method was superior to both a reduction in training intensity and total rest in the week prior to competition. It is generally accepted that the longer the athlete has been training for, the longer the taper can be. However, if training duration has been short, then a "drop dead" taper or 2-3 days where volume is dropped dramatically might be recommended.

NUTRITION FOR SUCCESSFUL ENDURANCE PERFORMANCE

Nutrition for the endurance athlete is crucial, particularly when undertaking regular, prolonged, or intensive training sessions. While an extensive discussion of sports nutrition takes place in a later section, in order to emphasize the importance of nutrition to the masters endurance athlete, a brief discussion will be undertaken here.



As noted earlier, it is not economical for an endurance athlete to be carrying body fat. Body weight normally remains quite constant throughout adult life suggesting that energy intake is closely matched to expenditure. However, there is often a trend towards increased body weight and body fat with increasing age. If body weight and performance levels are to be maintained in masters endurance athletes, the high rate of energy expenditure in training must be matched by a high energy intake or slightly reduced intake if the masters athlete is trying to lose fat mass.

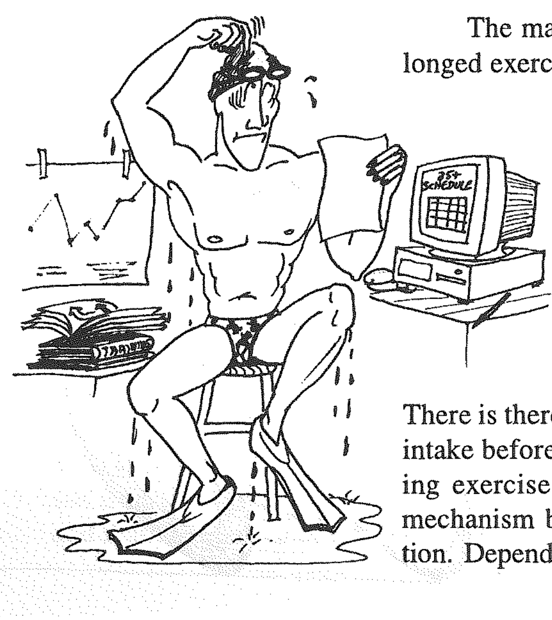
Effects of endurance training on the need for specific nutrients

The energy demands of training and competition are largely met by the breakdown of fat and carbohydrate with only a small contribution from protein. However, a protein intake of 1.2-1.7g/kg/day (see table 3 in nutrition chapter) is recommended for endurance athletes, an amount 50-100% greater than that recommended for non-athletes but still met by a well balanced and varied diet.

The higher the intensity of exercise, the greater the reliance on carbohydrate as a fuel. During low intensity endurance exercise, approximately two-thirds of the energy comes from fat with a third from carbohydrate. However, at 75% of VO2max (around anaerobic threshold), carbohydrate is the major fuel. If carbohydrate is not available, then exercise intensity must be reduced to a level where energy needs can be met by our large fat stores, even in the leaner masters athletes.

The major requirement for the masters endurance athlete is therefore carbohydrate. During training substantial depletion of the carbohydrate (glycogen) stores occurs from the working muscles and the liver. If these stores are not replaced before the next training session, the quality of the next session will be reduced, thus leading to poor training adaptations. As discussed in the nutrition section, the carbohydrates should be eaten or drunk ideally within 30 minutes of training finishing and should have a high glycemic index (see table 2 in Nutrition chapter). Carbohydrates should make up 70% of a masters endurance athletes diet. Moreover, carbohydrates should be emphasized leading up to an event lasting longer than one hour. This practice is called "carbohydrate loading" and will be discussed at length within the Nutrition section.

Water and Electrolyte needs



The major causes of fatigue during prolonged exercise are depletion of carbohydrate stores, particularly muscle glycogen ("hitting the wall" or "bonking"), and also problems with thermoregulation (heat control) and fluid balance. Mild dehydration (loss of 2-3% of body weight) impairs performance with severe dehydration being potentially fatal. There is therefore the real need to ensure fluid intake before, during and after exercise. During exercise in high temperatures, the only mechanism by which heat is lost is evaporation. Depending on exercise intensity, temperature and humidity, sweat rates can vary widely from 1.0L / hr to 2.5L / hr. The American runner Alberto Salazar reportedly lost 3.7L / hr during the 1984 Los Angeles Olympic marathon. Along with water, the major constituents of sweat are sodium and chloride although these are in abundance in the body and of less concern than the water loss.

As noted in the nutrition section (sports drinks) of this book, the major priority in events shorter than one hour is water replacement. Electrolyte (sodium, chloride and potassium) is not normally a priority, but the addition of sodium to glucose-containing drinks will enhance the absorption of both the water and glucose from the small intestine during exercise longer than an hour, particularly if the intensity of exercise is high and fluid losses great.

Effects of exercise on micronutrient needs

With regular strenuous training there is a need to balance food intake and energy expenditure. Provided the energy intake is "well-balanced" and contains adequate amounts of protein, minerals, vitamins and other dietary needs (fibre, carbohydrate, fats), there is no good evidence to suggest that supplementation of any of these dietary components is necessary or will enhance endurance performance. Seeking professional input from a sports dietician is strongly recommended for the competitive masters athlete. A sports dietician can ensure you are consuming a "well-balanced diet" through an analysis of your dietary intake over a 3-7 day period.

The only possible exceptions to the generalization about dietary supplements may be iron and, in the case of very active female masters athletes, calcium. Regular hard endurance training may result in iron loss, resulting in the need to increase dietary iron (meats, liver, green leafy vegetables). Exercise tolerance is impaired in the presence of anaemia (low haemoglobin or red blood cell counts). However, the masters endurance athlete may typically have low haemoglobin levels due to the dilutional effect an increase in blood fluid (an adaptation to endurance exercise) has on haemoglobin concentration. A sports physician or dietician can offer advice if this area is a concern. Because of the iron loss associated with menstruation, premenopausal female masters endurance athletes are generally more at risk of iron deficiency than men. The need for dietary iron is therefore a particular concern for these women if they train regularly.

Moderate endurance exercise has also been shown to increase bone density in both men and women. Hard training, however, may reduce circulating oestrogens and accelerate bone loss. For female masters athletes undertaking hard and regular endurance training, an adequate intake of dietary calcium should be ensured to help prevent bone loss. However, calcium supplementation alone may not reverse bone loss while oestrogen levels remain low.

RECOMMENDED READING

1. Borysewicz, E. (1989). ***Bicycle Road Racing.*** Vitesse Press, USA. ISBN number: 0-941950-07-7. Available from Vitesse Press, Box 1886, Battleboro, VT 05301-1886, USA. Cost: $30-40.
2. Burke, L. (1992). ***The Complete Guide to Food for Sports Performance.*** Allen & Unwin, Sydney. ISBN number: 1-86373-073-7. Available from QBD, Bookworld etc. or Allen & Unwin, 9 Atchison St., St Leonards, NSW 2065. Cost: $25-30.
3. Burke, L. & Deakin, V. (Eds) (1994). ***Clinical Sports Nutrition.*** McGraw-Hill, Sydney. ISBN number 0-07-470085-5. Available from McGraw-Hill, 4 Barcoo St., Roseville, NSW 2069. Cost: $70-75.
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6. Maglischo, E.W. (1993) ***Swimming Even Faster.*** Mayfield, Mountain View, USA.. ISBN number: 1-55934-036-3. Cost: $50-60.
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8. Newsholme, E., Leech, T., & Duester, G. (1994). ***Keep on Running: The science of training and performance.*** Wiley & Sons, England. ISBNnumber: 0-471-94314-2 . Available from Jacaranda Wiley, GPO Box 859, Brisbane, Q'ld 4001. Cost: $35-45.
9. Tinley, S. & McAlpine, K. (1994) ***Scott Tinley's winning guide to sports endurance: how to maximize speed, strength and stamina.*** KangarooPress, Kenthurst, NSW. ISBN number: 0-86417-630-9. Available fromKangaroo press P/L, 3 Whitehall Rd., Kenthurst, NSW 2156. Cost: $20-25.

CHAPTER 4
SPEED, POWER AND THE MASTERS ATHLETE

One of the most obvious things we notice as aging masters athletes is that we get slower. While some masters athletes I know may be faster than when they were younger through training smarter or through using a more scientific approach to their training, in general the frustration of slowing down hits us all. An examination of the track and field world records over 100m on the run track (see below) emphasize this finding.

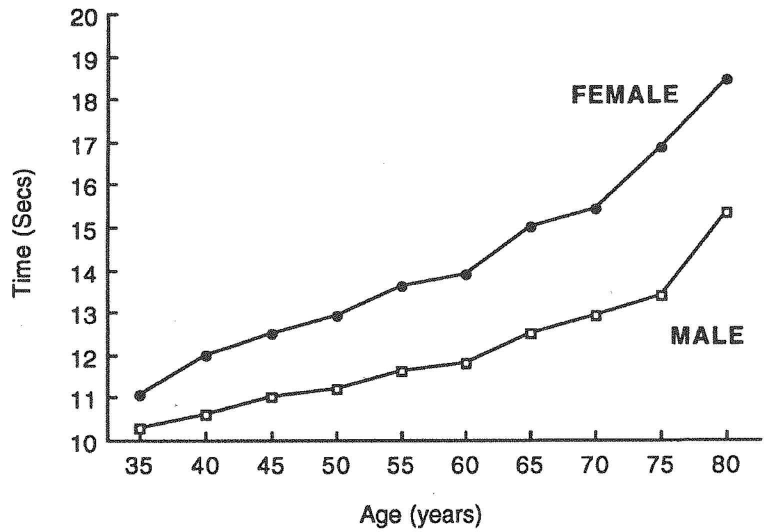

Figure 6. Male and female 100m track world records as at March, 1994

With few exceptions, my experience, particularly in masters swimming and through involvement with a number of veteran cyclists, is that too many masters athletes use endurance training methods and expect to go fast. This is not possible. The purpose of this chapter is to suggest a more scientific approach to sprint training in the older athlete.

Sprint times can be improved in three areas - speed development, speed endurance, and both starting and finishing technique. While the technique of starting and finishing are sports-specific and beyond the scope of this book, I shall focus on speed development and speed endurance.

SPEED DEVELOPMENT

Speed on the track or in the pool is a function of both stride length (distance per stroke) and stride (stroke) frequency. To improve speed, an increase in one or both of these must occur with sound technique maintained. Recent research of masters track sprinters revealed that stride length decreases significantly with age due to decreases in strength of the lower limb muscles and decreased hip flexibility. These findings strongly suggest that flexibility and strength training, particularly of the hip and knee joints, becomes critical for the masters track and field athlete requiring speed.

Speed in a pool, on the running or cycling track, or in team sports requires the following parameters to be developed - technique, short term power, speed, and speed endurance. Technique is developed through drills done at either race pace for short duration or longer duration at slower than race pace. Force production and movement speed must be optimal rather than maximal during technique development. This means that initially drills and technique work are done at slower than maximal speed until the technique is perfected and then speed increased. This is because it is crucial in speed development that all the muscle fibres involved in generating speed contract and / or relax at the same time. While drills such as high knee lifts in runners, "catch-up" drills in swimmers, or "one-legged pedalling" in cyclists are useful, repetitive sprinting under a coaches gaze will teach the muscles to co-ordinate movements.

Short term power is developed through resistance training in the gym that aims to develop power, hill running or cycling, starts, or short term (< 20 seconds) maximal efforts with full recoveries. These short intervals (eg 30-50m on the track or 12.5-25m swims) facilitate maximal and synchronous firing of muscle fibres. However, these intervals may lead to muscle damage and should be undertaken after muscles, ligaments, tendons, and joints have been strengthened through resistance training or lighter work at below maximal speeds.

Most athletes can only maintain maximal speed for 2-5 seconds. Speed endurance thus becomes important for most competitive masters events. Two schools of thought exist when we consider development of speed endurance or the ability to maintain speed. One school of thought suggests that all sprint training should be performed at 100% and the distances gradually increased. The other school suggests that technique should be preserved and that maximal speed in unconditioned athletes impairs technique. This school of thought suggests that initially training should be submaximal concentrating on technique then move to maximal speed as technique develops or is maintained. Speed endurance can therefore be developed through either maximal efforts of 10-45 seconds duration with full recoveries (2-5 minutes) or submaximal runs of similar or longer duration with shorter recoveries that enable form to be maintained throughout the workout.

SPEED TRAINING TECHNIQUES

A number of methods for developing speed are available. These include:

1) **Sprint-assisted training** such as downhill running (<3% grade), using a speed belt, towing behind cars (gasp!, gasp!) or in a pool with the coach pulling a hip harness and treadmill running all appear to lead to increases in stride length and frequency.

2) **Acceleration sprints** gradually increase from a rolling start, through jogging, to striding out and eventually sprinting at maximum pace. This type of training is useful for emphasizing maintenance of sprint technique as speed increases.

3) **Sprint-resisted training** such as uphill running, sand dune running, water running, weighted vest running, tethered swimming, or using a parachute or sled to increase strength and speed endurance.

4) **Hollow sprints** are accelerations and brief sprints interrupted by periods of recovery in the form of jogging or walking. This form of sprint training is appropriate to games players as it offers a variation in speed and tempo within each sequence.

5) **Repetition sprints** involves running distances at a constant speed (75-100%) with recovery periods of sufficient length to allow the athlete to maintain form and the required quality.

6) **Resistance or weight training** involves the strengthening of the muscles used in the sport or event. In sprint running the gluteals, hamstrings, quadriceps, calf, abdominals, lower back, and hip flexor muscle are critical. In sprint freestyle swimming the latissimus dorsi, triceps, and pectorals are important. A strength specialist should be consulted to develop a specific program for you. I STRONGLY recommend resistance training to the older speed and power athlete.

7) **Plyometrics** involves the athlete moving small resistances (such as body weight) with speed. Examples are hopping, leaping, and bounding.

PERIODIZATION OF SPEED TRAINING

While all the above training methods are useful in maximizing speed, they will be of minimal benefit if not sequenced correctly into your training program. A number of basic principles must be adhered to in the quest for speed. Firstly, to develop speed (as opposed to speed endurance), training must be performed in a state of minimal fatigue. That is, when you are fresh. The second principle is that the intensity of the speed training must be maximal. Thirdly, the total amount of speed work must be kept small.

A number of factors must be taken into account when planning your speed training. Firstly, when should speed training be done during the training session? As noted above, the aim of speed training is to develop the nervous and muscular systems together. It is therefore important that neither of these systems is fatigued when developing speed. The best way to ensure this is to do the speed work at the beginning of the training session. Speed drills can be included in the warm-up and followed directly by the speed development work.

The second question is when to place the speed sessions during the week? The important rule here is that you should do speed training after a minimum of 24-36 hours of rest or active recovery. This ensures that you are fresh and not tight from the previous training session. An example of a week might be below:

	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
am	Rest	Speed	Tempo	Drills	Speed	Tempo	Race
pm		Weights			Weights		

Figure 7. Example of a week allowing recovery for maximal speed (tempo = easy)

The reason for the weight sessions being held on the same day in Figure 7 is that heavy strength training creates significant nervous system and muscle fatigue. Thus, if done the day before a speed session, you may be fatigued from weights and not have good sprint form for your speed workout.

The third commonly asked question is what other training methods inhibit speed development? Short duration endurance work has no effect on speed. However, long runs, swims, or cycles do turn some of those fast twitch muscle fibres into fibres that are more like the slow twitch endurance type. As a sprinter you need all those fast twitch fibres for speed and power generation.

When during the training phase (preparation or competition) should speed work be performed? The consensus these days is all year round. The difference between the preparation and competition phases is in the intensity and volume of work performed. Speed running volume should be high all year round, but because the intensity of speed training during the preparation phase is lower than during the competition phase, the volume can be greater. The emphasis during preparation is on technique and developing acceleration through quality tempo runs and power-speed drills (plyometics or accelerations). These sprints are at 95% with strong emphasis on technique and fast, relaxed form. Recovery can be reduced to develop some aerobic endurance but not to the point where form is compromised. During the competition phase, the intensity of speed work is high (95%+) for most sessions. As a result, the recovery between repeats is longer and the volume per session reduced.

As you may have gathered, the method of periodizing speed development where low intensity, high volume training was followed by high intensity, low volume is now outdated. This approach can lead to great losses in explosive speed that cannot be recovered during the competition phase of the year. Thus, to maximize speed potential, speedwork should be carried out throughout the whole season. The emphasis is on quality, not quantity. This means that you need to be fresh for your quality speed sessions.

STRENGTH AND POWER

Strength is defined as the amount of force a muscle group can exert against a resistance in one maximal effort. Power represents the ability of the muscle to produce high levels of work (the product of force and the distance through which the force acts) quickly. Power is the result of strength and speed, both of which have been shown to decrease with age in the masters athlete.

Strength and power are important qualities in many masters team and individual sports and events. Analysis of force-time curves for different individuals clearly shows how athletes who have great strength can also have little power and vice-versa. In most sports, the time over which that strength can be exerted is very limited. For example, foot contact time in sprint running or jumping is approximately 150 milliseconds, meaning that the ability to quickly produce force is of paramount importance. For the masters power athlete, high levels of both strength and power are essential.

Resistance training is the name commonly described as training with weights. Speed-type movements require great muscular strength and muscular power - both of which can be enhanced through resistance training. For years older individuals have been told that resistance training should be avoided because of the dangers of elevated blood pressure and musculo-skeletal injuries. Proper technique and progressive overload in training, however, diminish the potential of either. Research shows that speed, power and strength are lost with age. The primary cause of this is

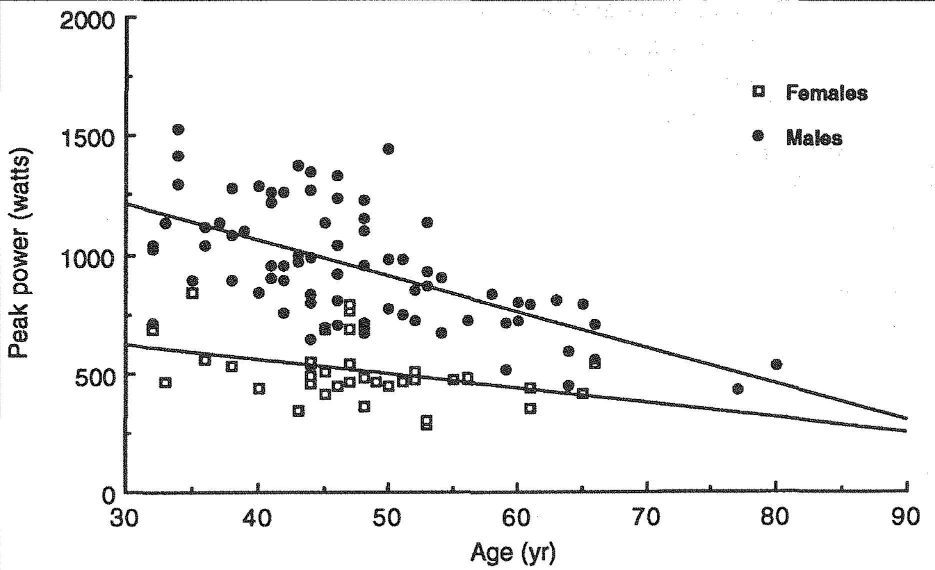

Figure 8. Peak power of masters track and field athletes

a decrease in nerve conduction and a drop in the number of high-powered muscle fibres (fast twitch fibres) leading to decreased muscle mass and therefore reduced ability to produce force. However, resistance training has been shown to positively modify strength, power and performance measures in both older non-exercising people and more recently older male and female track sprint athletes. We recently strength-trained eight male and eight female sprint runners for eight weeks and observed increases in muscle size (males only), muscle strength and power, and speed over 100 and 300 meters on the track in both males and female masters track sprinters. These results strongly suggest the need for hypertrophy (muscle enlargening) resistance training in the older power athlete who otherwise would exhibit decreases in muscle size and strength leading to decreased performance.

Training Techniques for Strength and Power

In order to improve power, a number of training options are available to the masters athlete. These include traditional weight training, dynamic plyometric training, and maximal power training.

1) **Traditional weight training** uses free weights or machines such as Universals and involves lifting relatively heavy loads (80-90% of maximum) for relatively few repetitions (4-8RM). 1RM is the maximum weight that can be lifted once, 4RM the maximum weight that can be lifted four times. This method is based on the theory that all fibres within a muscle will be used only when large

forces are required. This recruitment of all muscle fibres stimulates strength development with power developed if the nervous system is stimulated through doing each lift explosively.

2) **Plyometric training** uses the acceleration and deceleration of body weight as the training load in dynamic activities such as depth jumping, hopping, or bounding. This type of training first came to the fore in 1972 when the Russian sprinter Valery Borzov (100 and 200m Olympic champion) was reported to have used plyometrics. Plyometric training is seen as the bridge between strength and power and coaches of power athletes see strength training as a means of increasing general strength and plyometrics as the way to apply this strength to specifically improve performance.

3) **Maximal power training** involves the performance of dynamic weight training at the load that maximizes power output. This type of training involves lifting relatively light loads (30-45% of maximum) at high speed. Such training has been reported to result in the greatest training gains in power in young athletes. One critical point to note is that power training exercises must not be standard weight training exercises such as bench press or squats where the bar must be stopped at the end of the movement. Maximal power gains are experienced when the exercises are accelerated throughout the entire movement range, such as seen when performing weighted jump squats, wearing weight vests, or throwing heavy medicine balls.

The masters athlete with years of training in strength and / or plyometrics would be strongly advised to use such training methods. However, those masters athletes inexperienced in resistance training methods are strongly recommended to make contact with a gym that has qualified staff. The qualifications necessary are those from the Australian Strength and Conditioning Association or an appropriate degree (Physical Education, Human Movement Studies).

Planning the Power Development Program

If masters athletes are to achieve faster performances they must achieve higher maximum speed levels so as to allow greater speeds at less than maximal efforts. They must therefore develop both maximal speed and speed endurance. It thus makes sense to develop maximal speed throughout the training year or season in parallel with speed endurance training. Historically, speed endurance at submaximal speeds was developed prior to maximal speed that was developed in the last 4-6 weeks prior to major competition. A proper progression to develop speed should be:

- *develop proper sprint mechanics*
- *introduce higher intensity sprints over shorter distances that maintain technique*
- *work on speed development over distances less than 5-7 seconds in duration*
- *work on speed development over distances 7-20 seconds in duration*
- *maintain intensity of work between maximum and submaximum and only run, swim, cycle etc as far as technique will allow.*

As a general rule, the following factors need to be taken into account when developing a speed or power program.

- *The shorter the event, the greater the reliance on strength or power (eg. shot put)*
- *Where there are large resistances to movement such as body mass or other athletes -rugby union or league, rowing, weightlifting, then power development relies on strength*
- *Acceleration relies heavily on strength per kilogram of body weight*
- *Where resistance to movement is small, speed is more important than strength*
- *While speed is dependent upon genetics, speed can be developed through maximal speed training*
- *Speed and power training needs to be sequenced to optimize performance. For example, to develop power, the masters athlete should firstly hypertrophy (enlarge) muscles, then develop specific strength, then power.*

Conclusion

Three basic concepts appear important for speed. Firstly, it is true that "sprinters are born". Unless mum and dad have given us the right (and I know mine didn't!)

fibre type, body build, strength, and nervous system, we will find it hard to be quick. Secondly, "speed only comes from speedwork". Speed will only be developed through fast training where we teach our muscles to contract maximally and our nervous system to co-ordinate the movements. Too many masters athletes don't adhere to this concept and train slow to race fast. The final concept is "too much speedwork makes you stale". It would appear that speed is developed when we are fresh and our muscles and nervous systems are not tired. This strongly suggests that speed training should be done twice a week and at maximum three times with active rest in between. It also suggests that speed training be done at the start of a training session and not, as I often see in the pool or on the playing fields, at the end of a training session.

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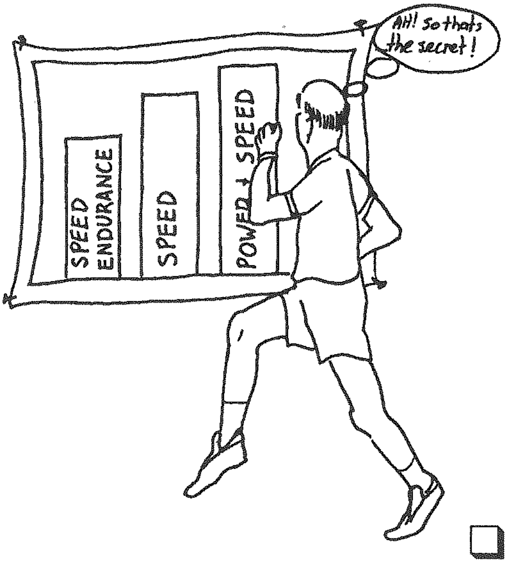


CHAPTER 5
STAYING WELL DURING TRAINING

Most of us that have trained regularly over a number of years have had minor or serious injuries, been tired as a result of training too hard or too often, or possibly even been victims of overtraining. I can vividly remember catching "triathlon fever" in 1986 and becoming overtrained through too rapid an increase in training volume.

Training can have both positive and negative effects on the older athlete's body. However, both young and older athletes are strongly advised against training when feeling ill (particularly with fever), after alcohol, if training is aggravating an injury, for consecutive hard weeks or periods, or when feeling very tired. The purpose of this section is to suggest ways the masters athlete can prevent tiredness or overtraining so that the training program can be maintained. These strategies include warming up, undertaking flexibility training, preventing fatigue, and using recovery and rest as training.

1) EFFECTIVE WARM-UP TECHNIQUES

The warm up prepares the masters athlete for the demands of your workout and aids in injury prevention. There are basically three components to an effective warm up and they should be performed in this order:

A. **Cardiovascular**

B. **Muscular**

C. **Skills**

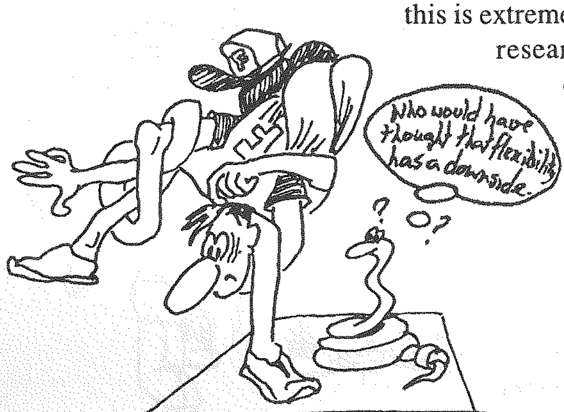
The cardiovascular warm up heats the body thus facilitating energy producing reactions to occur more quickly. The heart is also stimulated to deliver oxygen to the exercising muscles via the cardiovascular system, thus enabling the muscles to rely less on anaerobic (lack of oxygen) energy sources. The muscular warm up slowly increases the length of muscles (ie. stretching muscles) for injury prevention and better force generation. The skills warm up depends on the sport and involves replicating the skills you will need to use in the game or event. A power event should thus have some power work in the warm up to stimulate the nervous system while a ball-handling event should include specific ball handling drills as part of the warm up.

GUIDELINES FOR WARM-UP

1. Include cardiovascular work followed by muscular stretching and then skills practice (depending on your sport).
2. Warm up for at least 10 mins; if you haven't got 10 mins, 3 mins is better than nothing - everyone has 3 mins!
3. Under adverse environmental conditions (eg. cool, windy, wet weather) warm up longer.
4. Keep warm with appropriate clothing after warm up if you are not working out immediately.
5. Include some of the same activity as you will do in the main body of your workout.
6. If you can't actively warm up then do so passively using warm clothing, warm showers etc and stretch.
7. You do not need a lot of stretching in your warm up - concentrate on the cardiovascular warm up.
8. You should practice the warm up which you are going to use before competing.
9. Warm-up as close as possible to the start of your event.

2) DESIGNING A FLEXIBILITY PROGRAM

Flexibility is the range of motion at a joint or series of joints. In some sports this is extremely important. In the masters athlete, research has shown that flexibility decreases, particularly in the hip joint. This finding has strong implications for the older sprint runner who needs hip flexibility to ensure stride length, a major contributor to speed. Apart from performance enhancement, the main reason for including flexibility training into your workouts is for prevention of injury and optimal skill development.



Flexibility is best improved by stretching. There are four basic ways that stretching can be done:

a. **static** (the exercise is held at its limiting position for a short period)

b. **ballistic** (repeated movements often with swinging actions and change of direction at the end position)

c. **passive** (using a partner to hold a static stretch)

d. **PNF - Proprioceptive Neuromuscular Facilitation** (the muscle is first taken to its lengthened position and then actively contracted against resistance. After relaxing, the muscle is taken to a more lengthened position by an assistant)

GUIDELINES FOR STRETCHING

1. Stretch in both your warm-up and your cool down
2. Use mainly static stretching since it is safe and simple.
3. Do not overstretch into pain.
4. Hold the stretch for 10 to 30 secs.
5. Do 3 to 6 repetitions of each stretch
6. Use whole body stretches as well as specific stretches of training muscle.
7. Stretch muscles on both sides of limbs and both limbs alternatively to avoid imbalance.
8. Stretch throughout the year.
9. Consult a sports physiotherapist for advice on a flexibility program that will both enhance performance and prevent injury.

While the above guidelines recommend static or passive stretching, ballistic stretching may be recommended for athletes involved in ballistic activities at the end of the joints stretch range. Examples might be kickers, sprinters, or jumpers. However, ballistic stretching should always be preceded by a period of static stretching.

3) PREVENTING FATIGUE

An ideal training load causes just enough fatigue, thus creating a need for the body to adapt. As the training load is progressively increased, fatigue increases but should not be allowed to override the positive benefits of the body's adaptation. To avoid severe fatigue which will compromise the ability to continue training, the following guidelines are recommended:

1. Increase training loads gradually - no sudden increases in intensity, frequency or duration of workouts.
2. Get enough recovery and rest (eg. sleep, afternoon naps - wouldn't that be nice!).
3. Have regularly scheduled days off.
4. Change your daily routine sometimes eg. a different training venue.
5. Include regeneration and relaxation techniques whenever possible (eg. massage, meditation, yoga, baths with revitalising oils, spas, flotation tanks and visualisation exercises to release tension).
6. Eat well and drink plenty of fluids.
7. Consider additive effects of stressors other than training eg. emotional and work stress, poor climate, lack of time etc.
8. Keep a log book and monitor mood, performance, skill changes muscle soreness and how you're feeling - this will help you LISTEN TO YOUR BODY.
9. Watch for warning signs of overtraining (see below).

SIGNS OF OVERTRAINING

Overtraining is caused by lifting intensity, frequency, or duration of training too quickly and not having adequate recovery to allow adaptations to take place. While not totally exhaustive (pa the pun!), the following signs or sy toms may help you recognize whe you are overtraining. Research shown that no one sign (not ever well used resting heart rate) is the l How you feel in general appears t the best marker of overtraining how you feel is generally a comb tion of many of the factors below

Physical Signs

- *Performance decrements*
- *Decreased ability to train effectively*

- *Elevated resting heart rate*
- *Slower heart rate recovery*
- *Gastrointestinal disturbances*
- *Muscle soreness*
- *Headaches*
- *Increased susceptibility to colds, cold sores, infections*
- *Menstrual disturbances*
- *Loss of appetite*
- *"Heavy Legged" feeling*
- *Elevated blood pressure*
- *Deterioration in sporting skill*

Emotional & Behavioural

- *Chronic Fatigue*
- *Apathy*
- *Depression*
- *Anxiety*
- *Irritability*
- *Sleep Disturbances*
- *Boredom*
- *Low Motivation*
- *Inability to Relax*
- *Mood Changes*
- *Poor Coordination*
- *Decreased Self Confidence*

Listen to your body and watch for these signs of overtraining. If observed, act quickly to reduce the symptoms of overtraining by using some of the strategies outlined in this section. If overtraining symptoms persists, contact a sports physician for professional advice.

4) RECOVERY AND REST

Recovery is the restoration of physiological and psychological states which have been altered during training. Including recovery as an integral part of your training will avoid overtraining syndrome, improve your chances of keeping well, keep you free of injuries and increase the training workloads you can tolerate. Recovery is also needed to allow energy stores to be replenished (eg. carbohydrate), remove metabolites (eg. lactic acid) and for tissue repair. There are three main considerations:

A. Work/Rest Ratios

B. Nutrition

C. Regeneration Aids

a. Work / Rest Ratios

Training overload and recovery phases must occur in sequence if you are going to get the most from your training. These vary within and between workouts. As a general rule of thumb, an endurance athlete needs recoveries between intervals that are approximately half to one-third the length of the preceding interval. Conversely, the sprint or power athlete needs almost full recovery between efforts to maximize speed and power development. The body also needs recuperative time to allow for adaptive changes to occur between workouts. LISTEN TO YOUR BODY. If you are continually tired or irritable you may not be incorporating enough recovery between workouts.

b. Nutrition

Good nutrition is an important part of your training regime. Your nutrition has an impact on your training and competitive performance and an effect on your immediate and long term health. Rehydrating and refuelling are important parts of recovery. Your training diet must provide (1) enough fuel, (2) enough fluid and (3) essential nutrients for good health. The section on nutrition in this book contains strategies to maximize recovery using nutrition.

c. Regeneration Aids

These include meditation, flotation tanks, massage, spas, hot and cold showers, cross-training (swimming or cycling) and can greatly aid your recovery.

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CHAPTER 6
SPORTS MEDICINE

While we all make every attempt to train injury-free, some of us either overtrain or are pre-disposed to sports injuries due to our anatomical structure or poor training technique. The purpose of this chapter is to examine the possible causes of these injuries, ways we can prevent them, and if we suffer an injury what we can do about it.

INJURIES AND THE MASTERS ATHLETE

A number of biological changes occur in bone, cartilage, tendons, muscles and ligaments during aging that theoretically make the older athlete more susceptible to sports-related injuries. Specifically, the water content of the above connective tissues decreases, thus reducing the elasticity within cartilage, ligaments and tendons. Muscles also lose their strength while bone density is reduced by 0.3% to 0.5% per year for both men and women after 40 years, with this rate accelerated in post-menopausal women up to 2-3% per year.

However, the above research is based on non-exercising aging people with there being no evidence to suggest that older athletes suffer injuries at a greater rate than younger athletes. Indeed, a recent study undertaken at Stanford University in the United States observed that older people who engage in vigorous running and other aerobic activities have lower mortality (sickness) and slower development of disability than do members of the general population who are the same age. Research on injury and training patterns in the older athlete has also suggested that older athletes tend to train at a slower pace, with greater "mileage", and tend to enter longer distance races than the younger athlete. This may make the older athlete more susceptible to overuse injuries than the younger athletes, particularly if the masters athlete is doing those longer distances with poor technique.

Research has confirmed that when injuries do occur in the older athlete, they are generally due to overuse and most often observed in the lower extremity. A study published recently in the British Journal of Sports Medicine examined sports-related injuries in 97 male athletes (70-81 years) from a variety of primarily endurance sports over a ten year period. They observed that 75% of the injuries occurred in the legs with most injuries being observed in the knee (20%). Sprains of the knee and thigh were the most common acute injury.

Research clearly shows that the majority of injuries in athletes (both young and old) can be tracked to a certain cause - such as overtraining - and with a little planning masters athletes can avoid most common injuries. As noted above, most injuries in masters athletes are caused by overuse, faulty biomechanics (technique), or poor flexibility.

1) OVERUSE

The majority of aches and pains are due to overuse. In runners, each running step requires your body to absorb three to four times its weight for many kilometers, cyclists complete 80-100 revolutions of the legs each minute for hours on end, with swimmers completing 40-50 strokes per 50 meters for lap after lap. The repetitious nature of such exercise can lead to breakdown and injury. However, use of the following guidelines can help reduce your risk of overuse injury:

- *Build kilometers slowly. As a rule of thumb, increase distance by no more than 10% a week.*
- *Do not routinely increase distance by 10% per week. Have easy weeks and hard weeks by varying intensity, distance, and frequency of training.*
- *Follow hard days (either intensity or distance) by easy days.*
- *Incorporate some cross-training. Replace a running day with swimming, cycling, or walking. This will still give you an aerobic workout while giving the trained muscles a rest.*
- *The risk of overuse injuries increases dramatically the more kilometers undertaken. Learn your limits and maintain that limit if you start getting aches and pains. Increase intensity and recoveries to keep enhancing performance if kilometers become limiting.*
- *Racing places enormous stress on your body. Plan a racing schedule that allows adequate recovery between events. Train easy for a few days after an event.*

2) BIOMECHANICS

Biomechanics is the study of the forces acting on the body during exercise. Faulty technique places abnormal forces on muscles, bones or joints. In running a common example is pronation (rolling in of the ankle joint) as the foot lands. If you feel you have faulty running technique, see a sports physiotherapist or sports podiatrist who are trained to analyse technique and foot function. In masters swimmers a common injury is swimmers shoulder. While this complaint may be due to overtraining, it is often due to poor technique (not enough body roll) or inadequate shoulder flexibility. In veteran cyclists knee pain behind the knee cap is often experienced due to pushing big gears too often or too long or poor bike set up.

Prevention of biomechanical problems can often be prevented by seeing a sports physiotherapist before commencing training and having them give you a musculo-skeletal profile. This profile examines your strength and flexibility characteristics in relation to the demands of your sport or event. A good coach will also ensure you are training with correct technique prior to commencing harder training where the risk of injury increases. Finally, ensure you are using the correct equipment (eg. running shoes, bike set-up) that suits your body type and style. A reputable bike dealer or specialist running shop will be able to assist here.

3) FLEXIBILITY

Training and competing have many benefits, but increased flexibilty is not one of them. As training increases muscle strength, it also shortens and tightens muscles. Tight muscles and tendons restrict your range of motion around a joint. Stretching before and after training and competition is extremely important. If you have concerns in this area, see a sports physiotherapist who will prescribe a stretching program for your specific needs. The following guidelines are important when stretching:

- *stretch the joint till you feel the pull and hold (don't bounce).*
- *hold the stretch for 15-30 seconds.*
- *repeat the stretch three times.*

See the recommended books on stretching at the end of this chapter for some safe stretches for your sport.

Now that we have examined the common causes of injuries in the older athlete, we will discuss the more common injuries from running, swimming, cycling, rowing and tennis.

Common Running Injuries

1) Plantar Fasciitis

Pain in the heel or arch area is often plantar fasciitis or heel spur syndrome. This is an inflammation of a fibrous band of tissue which stretches from the heel to the toes. Pain may be present in the morning, after rest, or after running. The pain is usually worst upon waking or at the start

of a run. Chronic plantar fasciitis may lead to the formation of a heel bone spur. Flat feet and high arch feet are prone to these injuries. Treatment may include a combination of rest, stretching, taping, change in shoes, arch supports or custom orthotics (shoe inserts), and anti-inflammatory drugs. See a sports podiatrist if you are suffering from the above symptoms.

2) **Knee pain**
The most common knee injury in runners is chondromalacia patella. This occurs when the patella (knee cap) rubs up against the femur (thigh) bone. Chondromalacia is often caused by excessive pronation or muscle weakness around the knee joint. Rest and icing should reduce temporary pain. If it is caused by excessive pronation, shoe inserts may help. Strengthening the quadriceps will help if the problem is due to muscle weakness. A sports physiotherapist can be invaluable in assessing the problem and its cause.

   Another common cause of knee pain is iliotibial band (ITB) syndrome which causes pain on the outside of the knee. The onset of pain is usually slow and appears after running a certain distance. The major causes are excessive internal rotation of the leg and pronation both of which cause the ITB to be stretched over the lump on the outside of the thigh bone. Treatment includes rest, icing, eliminating overpronation, and stretching the ITB. Again, a sports physiotherapist or podiatrist can be invaluable in assessing these problems and their causes.

3) **Achilles Tendonitis**
Tight calf muscles, poor stretching habits, and excessive distance on hard surfaces and hills may lead to this progressive degeneration and weakening of the Achilles tendon. Heel lifts, icing, and anti-inflammatories in conjunction with rest, often speed healing. However, it is often necessary to stop running until the injury is healed. Achilles tendonitis can often be prevented by good stretching habits before and after running and a progressive increase in distance and intensity of training.

4) **Shin Splints**
Muscle and tendon weakness in the front or inside of the lower leg may lead to the sharp pain often referred to as shin splints. Stress fractures may occur if shin splints are left untreated. Excessive pronation, too rapid an increase in distance or intensity of training, running on hard surfaces, and downhill running are leading causes. Treatment consists of rest, icing, and anti-inflammatories. Prevention is through muscle strengthening of the lower leg muscles, a progressive increase in training load,

correct running technique, and running on softer surfaces.

Running injuries respond quickly if treated early and properly. While rest, dropping mileage or intensity, and icing are the first line of defense, self-treatment does have its limits. If acute pain does not respond to rest, a consultation with a sports physiotherapist or podiatrist is strongly recommended.

Common Swimming Injuries

1) **Swimmer's Shoulder**
Most masters swimmers will suffer this injury during their career. It is usually due to overuse, a rapid rise in training volume or intensity, sudden use of paddles, poor warm-up, poor technique (inadequate body roll), or poor flexibility in the shoulder joint. The pain is caused by a rubbing or impingement of muscle tendons on or between bones. Treatment is by icing, stretching and strengthening, or by physiotherapeutic means. To reduce the risk of injury, the following guidelines are suggested:

    - *warm-up with light swimming gradually building intensity*
    - *stretch the shoulder joint before, during and after training*
    - *bilateral (both sides) breathing*
    - *ice the shoulders after training (use a bag of peas)*
    - *strength train the muscles that oppose the pull (back of the shoulders) with weights or large rubber bands such as surgical tubing.*

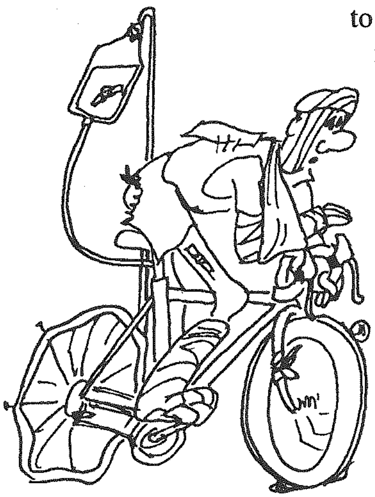
2) **Swimmer's Ear**
This condition is often experienced in swimmers with small ear canals who swim in warm water or water that is poorly cleaned. Prevention is by wearing ear plugs and drying the ear after training through use of a towel or drying ear drops that are a combination of a drying agent (alcohol) and mild acid (vinegar) or products commercially available from chemists or pool shops. I often see masters swimmers using cotton wool buds to dry the ears. This practice only aggravates swimmers ear because it takes away the protective wax coating in the ear that helps prevent the condition.

3) **Breaststroker's Knee**
This injury is due to the sudden snapping action of the knee as it straightens causing the kneecap to shift and rub on the thigh bone, leading to pain under the kneecap. The injury requires rest until pain subsides, icing, and anti-inflammatory drugs. The swimmer can use another swim stroke and breaststroke arm drills to maintain general condition until the knee is healed. Strengthening of

the quadriceps' muscles, together with improved knee flexibility will help prevent the problem.

Common Cycling Injuries

Cycling is a lifetime sport with excellent physical and psychological benefits to the masters athlete. However, because of the repetitive nature of the cycling stroke, it is essential that the masters cyclist is both physically conditioned and that the bicycle must fit the veteran cyclist perfectly. Proper positioning is not only important from an aerodynamic perspective, but also to prevent many of the overuse injuries seen in cyclists. Correct positioning can be done through an accredited coach, reputable bike shop, through using the recently-available "Fit-kit", or reading the recommended readings at the end of the chapter.



Injuries in cycling result from accidents or overuse. Injuries from accidents usually occur in the upper body and are more commonly observed in inexperienced riders. Overuse injuries consist of compression injuries, inflammatory injuries and muscle strains and are generally the result of poor technique, poor positioning, or excessive stress through increasing training intensity or duration too quickly. Overuse injuries primarily occur in the lower extremities and back and include knee cap tendonitis, Achilles tendonitis, chondro-malacia patella, or iliotibial band inflammations. Masters cyclist may be more susceptible than youngsters to upper body overuse injuries such as shoulder bursitis, or nerve conduction problems (numbness).

The standard treatment for overuse injuries is rest, elevation, immobilization, ice, and the use of nonsteroidal anti-inflammatory agents. As the overuse injury is rehabilitating, massage, stretching, and progressive resistance training is recommended. However, the key to avoiding overuse injuries is prevention. This includes proper shoes, positioning, bike frame size, saddle and foot positions, and pedalling technique being

checked by a qualified coach or at well-respected bikeshop. Upper extremity problems can be prevented through correct seat height, using padded gloves, frequently changing hand positions, not resting on the hands, and strengthening of the abdominal and lower back muscles.

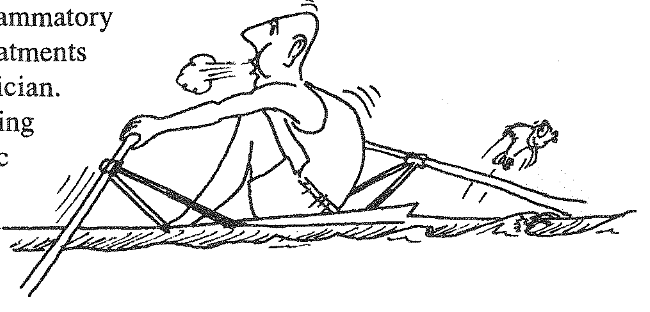
Common Rowing Injuries

Rowing is a sport that requires technical skills, co-ordination, strength, and considerable endurance. The rowing stroke is divided into the catch, the drive, the finish, and the recovery. Incorrect co-ordination and / or poor repetitive technique of this sequence may lead to injury. While the legs initiate the drive, the trunk is the major contributor to the linear velocity of the oar. The masters rower needs to ensure that trunk muscle (abdominals and lower back) strength is adequate. This is achieved through resistance training.

The two most commonly injured areas in rowing are the knee and back. The knee is subjected to considerable repetitive knee bending and straightening (through rowing itself, weight lifting, running or cycling) which generates large compression forces on the knee joint and the knee cap. Masters rowers are advised to watch for signs of crepitus (grating), swelling, or discomfort during or after training. While input from a sports physician is recommended, rest, treatment with non-steroidal anti-inflammatory medications, isometric quadricep exercises, and hamstring and quadriceps stretching are suggested.

Low back pain is commonly observed in male and female masters rowers, particularly in those with a previous history of low back pain. Off season training should include strengthening of the abdominals, stretching of the hamstrings and lower back, technique training, and a gradual progression in training intensity and duration. If the problem is recurrent, the intervention of a sports physician or physiotherapist is strongly recommended since the pain may be due to a herniated disc or spondylolysis (backbone degeneration).

Rib stress fractures, while not common, may occur, particularly in the older rower during strenuous training. These are due to the high bending forces on the ribs on the rear and lateral side of the chest as it expands and contracts during the rowing stroke. The signs are local tenderness and discomfort on compression of the chest. Rest (6-8 weeks), the use of analgesics (panadeine etc), or anti-inflammatory drugs are recommended treatments after visiting a sports physician. Cross training through cycling will help maintain aerobic conditioning while the fracture is healing.



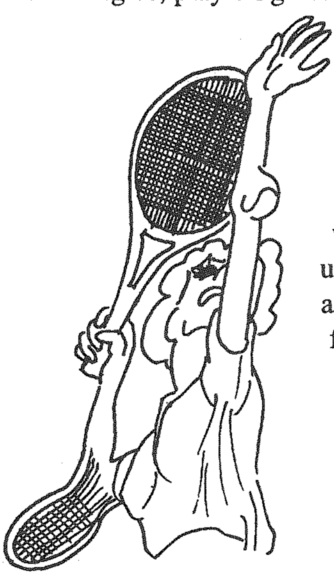
Extensor tenosynovitis is often observed during early season workouts. It is caused by repetitive bending of the wrist during the finish and recovery phase of rowing. The small muscles of the wrist become compressed, often resulting in pain, swelling or crepitus (grating). Treatment consists of a wrist splint, anti-inflammatory drugs, and rest (2-3 weeks) with physiotherapy including ice initially followed by heat and ultrasound. Steroidal injections into the tendon sheath may be helpful in severe cases but not recommended routinely. Prevention includes a gradual progression in training, gripping the oar with the fingers and relaxation of the wrist while feathering the oar.

Common Tennis Injuries

Tennis is a lifetime sport requiring skill, speed, endurance, strength and flexibility. The skill component is affected by the deteriorations in the physical capacities which occur with aging, albeit to a lesser extent than those older people who do not exercise.

Most of the injuries that occur in the veteran tennis player are chronic but acute injuries such as tears of the knee cartilages and tears of the Achilles tendon and rotator cuff do occur. While surgery and rest for up to 6 weeks may be required with knee and serious tear injuries, the tearing injuries may be prevented through specific stretching and a progressive warm-up.

Chronic or long term injuries generally don't disable but are a problem to the player. The potential for such injuries increases with age and frequency / duration of playing. Knees injuries may be the result of previous injuries or degeneration of the knee cartilages. Players may need to decrease the amount of play, play doubles instead of singles, play on grass or clay, or use anti-inflammatory drugs. Strengthening and stretching the knee muscles (quadriceps, hamstrings, calves) is also advised.



Tennis elbow or tendonitis of the wrist extension muscles is common in veteran players. In the older player, strengthening and stretching the wrist joint is critical in preventing this injury. The use of counterforce braces, correct stroke technique, and decreasing playing or training time can be helpful.

Rotator cuff tendonitis is diagnosed when pain is observed on serving, hitting overheads, or high volleys. It is usually due to weakness and / or inflammation of a muscle in the back of the shoulder (supraspinatus). Stretching and strengthening the muscles of the upper back are recommended, particularly the muscles of the rotator cuff. A visit to a sports physiotherapist is strongly advised.

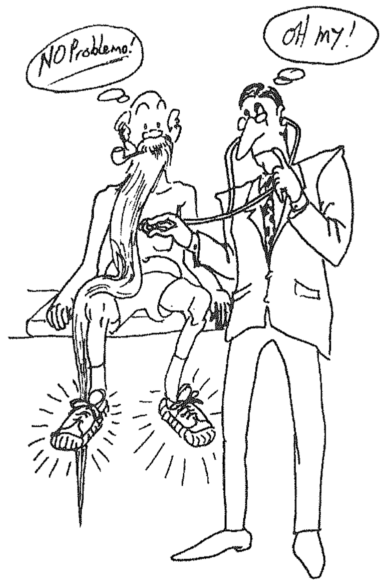
Back pain is a significant cause of disability in the senior tennis player. A sports physiotherapist should be consulted to ensure the pain is not due to conditions that might require surgery. Flexibility of the back extensors and flexors is strongly recommended, as are resistance training programs that emphasize abdominal and back extensor muscles. Again, the sports physiotherapist or strength and conditioning specialist should be consulted to ensure a safe and effective resistance training program that can be developed for home use.

I have repeatedly made the recommendation that the masters athlete, particularly the athlete having taken many years off training, should visit a sports physician or physiotherapist and have a pre-participation examination. I will now discuss what that examination should include.

THE PRE-PARTICIPATION PHYSICAL EXAMINATION

The masters athlete is strongly advised to undertake a regular medical check-up by a sports physician (a qualified sports medicine specialist). This becomes more important the older the athlete becomes or if the athlete is commencing training after years away from sport. The American College of Sports Medicine has long recognized that particular risk factors may be present in an older athlete that increase the risk of cardiovascular disease. They have devised categories that are summarized below:

- ***Group A*:** Individuals younger than 45 years who are healthy and have no major coronary risk factors (see below). This group should be exempt from medical testing.
- ***Group B*:** Individuals 45 years or older who are healthy and have no major risk factors. These masters athletes should have a maximal exercise stress test and a complete physical examination before commencing a fitness program.
- ***Group C*:** Individuals 35 years or older who have no symptoms but who have at least one major coronary risk factor. These persons should undertake a maximal exercise test and a complete



physical examination before commencing a fitness program.

- *Group D:* Individuals, regardless of age, with at least one major risk factor or symptoms suggestive of cardiac, lung, or metabolic diseases. These persons should undertake a maximal exercise test and a complete physical examination before commencing a fitness program and should be counselled regarding heart rates and monitored closely.
- *Group E:* Individuals, regardless of age, with known heart, lung or metabolic disease. Persons in this category incur undue risk if they involve themselves in strenuous exercise.
- *Group F*: Individuals, regardless of age, who are medically unstable and deemed high risk by their family doctor. Persons in this category incur undue risk if they involve themselves in strenuous exercise.

Coronary Disease Risk Factors

The following factors are recognized as the major risk factors in heart disease:

1) Diagnosed hypertension or systolic blood pressure greater than 140mmHg or diastolic blood pressure greater than 90mmHg on at least two separate occasions, or on antihypertensive drugs.
2) Serum cholesterol greater than 5.5mmol / L.
3) Serum triglyceride (a form of fat) greater than 2.0mmol / L.
4) Cigarette smoking.
5) Diabetes mellitus. Individuals with Insulin Dependent Diabetes Mellitus (IDDM) who are over 30 years of age, or have had IDDM for longer than 15 years, and persons with Non-Insulin Dependent Diabetes Mellitus (NIDDM) who are over 35 years of age.
6) Family history of coronary disease in parents or siblings prior to age 55.

Monitoring for cardiovascular disease risk factors is an important but small part of the overall screening process for the healthy masters athlete. While no guidelines exist for the screening, the pre-participation physical exam for the masters athlete should consist of the following:

- *personal and family medical history*
- *joint examination - pain, range of motion, stability, and strength of major muscle groups, particularly those used in the sport or important for injury prevention*
- *spine examination — back and neck pain, range of motion*

- *muscle and tendon examination - elasticity of tendons, tendonitis, bursitis, muscle aches, ruptures.*
- *flexibility — joints used in the sport(s).*
- *coronary heart disease risk factors (see above).*

The masters athlete is strongly advised to undertake such a screening process yearly or prior to commencing hard training, particularly after years away from intense training or competition.

MEDICAL CONCERNS AND THE MASTERS ATHLETE

Apart from the coronary disease risk factors outlined earlier, a number of symptoms are a concern if seen when we train or compete. These symptoms or signs may be seen in an older person who has made the decision to commence a training program after years of no exercise.

1. **Chest pain**
   Chest pain while training and relieved by rest is a strong indication of angina (cardiac pain). It is characterized by tightness in the centre of the chest and may radiate into the jaw, the left or both arms, and even the back. It may also be bought on by anxiety, food or cold temperatures. The masters athlete displaying these signs should visit a sports physician who may then refer to a cardiologist for more detailed examination. Both a resting and exercise electrocardiogram may be normal with the only definite means of identifying heart disease being an angiogram where dye is put into the bloodstream.

2. **Breathlessness**
   Shortness of breath may be produced by reduced oxygen delivery to muscles due to low fitness levels, airway obstruction, lung or cardiac disease. This symptom, particularly if combined with other warning signs, strongly suggests a visit to your sports physician.

3. **Palpitations**
   Most of us are aware of the rapid pulse observed during exercise or when anxious. However, medical intervention is advised when the pulse is irregular or rapid and associated with chest pain, dizziness, or breathlessness.

4. **Dizziness**
   Faintness or fainting on completion of exercise is usually due to the blood pooling in the legs or arms and is due to a drop in blood pressure as a result of the blood vessels in the exercised muscles

remaining dilated. However, older people are more prone to falls in blood pressure when rising quickly from a seated or lying position. This is more likely to occur if the person is taking diuretic (fluid loss) or anti-hypertensive drugs or dehydrated following exercise. Regular fainting may be serious and warrant medical intervention.

5. **Fatigue**
   Undue fatigue may be related to poor fitness, illness, or medication such as tranquillizers or beta-blockers. However, in masters athletes, it may also be due to overtraining which is characterized by decreases in training and competitive performances, a possible elevation of resting heart rate, increased susceptibility to injury or illness, insomnia, or anxiety, irritability, or depression. Again, a sports physician should be contacted.

COMMON MEDICAL CONDITIONS AND THE MASTERS ATHLETE

A number of common medical conditions are observed in both young and older athletes. The aging process and the possible increased risk of overtraining, may make the masters athlete more susceptible to many of those listed below.

Infections

In the presence of infections such as colds, sore throats, influenzas, vomiting or diarrhoea, particularly if combined with a fever, exercise should not be undertaken or at least reduced in intensity. Antibiotic therapy should not interfere with training unless it produces nausea, abdominal pain, or diarrhoea. However, if the infection requires antibiotics then you are probably not fit to train or compete. Many of the commonly used analgesics (eg. codeine) and decongestants (eg. ephidrine) are banned substances due to their beneficial effects on exercise performance.

Cardiovascular Disease

Approximately 50% of deaths in Australia are due to cardiovascular disease (CVD). As noted earlier, the risk factors for CVD include a family history, age, hypertension, diabetes, high blood cholesterol, smoking, obesity, and a sedentary or stressful lifestyle. While it is well recognized that a healthy lifestyle including athletic diets and regular exercise lowers the incidence of CVD, unaccustomed intense exercise increases the risk of sudden death in those with CVD risk factors. Indeed, 15-30% of sudden deaths are exercise-related and occur in individuals who have ignored pre-existing CVD warning signs. Medical screening according to the guidelines given in Table on page reduce the risk of a CVD crisis.

A number of drugs are commonly used to treat cardiovascular disease. Use of Digoxin may slow the pulse rate, lead to loss of appetite, and make the athlete sluggish but has no effect on performance, nor is it an International Olympic Committee (IOC) banned drug. Anginine is used to treat angina and may lead to headaches, low blood pressure, and susceptibility to fainting. However, it may improve the tolerance to exercise in older people with angina. Beta-blockers are a group of drugs that help control high blood pressure by slowing down the heart rate. They also reduce hand and arm tremor and are therefore banned by the IOC because sports such as archery, shooting, diving, and modern pentathlon may benefit. Beta-blockers reduce aerobic performance and may cause lethargy, insomnia, and possible aggravation of asthma. Diuretics are commonly used by athletes to lose weight quickly through increased fluid loss through the kidneys and urine. They may lead to dehydration, low blood pressure, increased blood sugar, and muscle cramps. However, despite being an IOC-banned drug group, they may improve exercise tolerance in people with heart failure. Anticoagulants prevent blood clotting and therefore lead to increased susceptibility to bleeding and may lead to anaemia in injured athletes. A more detailed discussion of drugs in sport will follow later in this chapter.

Hypertension

High blood pressure affects 1 in 6 people. Hypertension is diagnosed as blood pressure persistently above 140 / 90. Borderline hypertension may respond to non-drug measures such as reducing blood cholesterol, alcohol, and smoking consumption or reduction in stress. However, when blood pressure is above 160 / 95 consistently, beta-blockers, calcium antagonists, or ACE inhibitors may be prescribed with the ACE inhibitors preferred for athletes. Regular exercise may be associated with reductions in blood pressure with the exercise-associated reduction in body weight and body fat helping reduce blood pressure. Isometric training or heavy weight lifting (particularly above the head) can be associated with rapid elevation of blood pressure and should be avoided in hypertensive older athletes.

Respiratory Disease

These diseases include asthma, chronic bronchitis, and emphysema that may result in shortness of breath and coughing. Asthma may be induced by infection, airborne irritants such as pollen or pollution, emotions, or exercise. Maximal exercise longer than 5-6 minutes often induces an asthmatic attack. The duration, intensity, and type of activity determine the potency of the attack. Distance running, for example, is more potent than intermittent sports such as tennis. Dry land exercise is more potent than water sports, probably due to the fact that cold, dry air is more irritating than warm, moist air. This would strongly suggest swimming as a viable exercise alternative for the asthmatic athlete.

Exercise-induced asthma is often followed by a refractory (delay) period of 1-2 hours during which a further recurrence will not occur. This suggests that some athletes may be able to undertake a progressively harder warm-up that induces a mild attack which may leave them attack free for the main competition. Pre-exercise medication using a beta-adrenergic agonist (eg salbutamol, terbutaline, or sodium chromoglycate - Ventolin, Bricanyl, Respolin) are beneficial in preventing or reducing the severity of an attack. While these substances are banned by the International Olympic Committee, the masters sports drug policy (see later) allows use of these drugs for medicinal purposes. Thus, an asthmatic masters athlete should:

- *select a non-irritating environment*
- *choose an interval training program*
- *ensure an adequate warm-up*
- *use medication before, during and after as required.*

Diabetes

In diabetes, the pancreas does not produce sufficient insulin for the breakdown of glucose, the level of which rises in the blood (hyperglycaemia) followed by its excretion in the urine where large volumes of water are lost. In contrast to high blood sugar, low blood sugar (hypoglycaemia) may occur due to too much insulin in the blood, insufficient calories in the diet, or following exercise which increases uptake of glucose by the muscles.

Insulin dependent diabetes is due to impaired pancreatic insulin secretion. This means the insulin dependent diabetic must manage the disease by administration of insulin injections. The lower limbs should be avoided for injections since insulin absorption will be more rapid during running. Monitoring of blood glucose levels during exercise is strongly recommended to establish insulin needs. However, glucose supplements (lollies, sugar) should be carried during exercise just in case hypoglycaemia does occur. In athletes, there may be a 30-40% reduction in insulin requirements during exercise due to increased muscle blood flow and glucose uptake by muscles.

Non-insulin dependent diabetes usually occurs later in life, is generally associated with obesity, and is due to a reduced sensitivity of muscles and other tissues to insulin. Weight loss and dietary interventions are key steps in management. Exercise is associated with improved glucose tolerance. That is, the muscles and tissues increase their sensitivity to insulin which leads to better diabetic control and a reduced drug dosage requirement. Exercise may also induce weight loss and a lowering of blood fats which will reduce the risk of cardiac crisis. The risks of exercise in the non-insulin dependent diabetic include hypoglycemia (carry sugar to prevent), foot trauma (loss of feeling in the feet may lead to injury), and bleeding in the eye due to the rise in blood pressure.

Arthritis

Osteoarthritis (OA) is the mechanical deterioration of the joints which occurs during middle and old age. OA mainly affects the weight-bearing joints such as the knees, hips and spine and is more likely to occur if the joint has been previously injured, particularly if the cartilage in the knee joint has been removed. There is no scientific evidence to suggest running leads to premature OA. However, once OA has developed, running may have to be reduced or stopped. Exercises that maintain muscle strength and joint mobility are important, particularly in the knee, lower back and abdominal areas. Hydrotherapy (water running, aquarobics) in a heated pool is suggested.

Rheumatoid arthritis (RA) is an inflammatory disease, often inherited, that affects many joints throughout the body. When the pain of inflammation is not bad, a program of exercise emphasizing flexibility and strength is suggested, again in the warm water environment. Rest remains the ideal treatment when inflammation occurs and exercise is limited by pain. The major drug treatment for arthritic conditions is analgesics such as paracetamol, codeine (an IOC banned drug), aspirin and Non-Steroidal Anti-Inflammatory Drugs (NSAIDS). The majority of NSAIDS are metabolized in the liver and excreted in the kidneys so that lower doses should be used in masters athletes where kidney function may be impaired due to age. NSAIDS should only be taken under the supervision of a qualified medical practitioner and only for a few days due to the increased risk of bleeding ulcers and possible kidney failure with chronic use.

Osteoporosis

Osteoporosis is a reduction in the bone mineral content of the bones. It primarily occurs in post-menopausal women and predisposes them to fractures of the hip, wrist and spine. Low levels of oestrogen (also observed in pre-menopausal women who lose their periods due to high levels of training), low levels of calcium, and lack of weight bearing exercise are factors contributing to osteoporosis. Current opinion suggests that oestrogen supplementation together with adequate dietary calcium intake and regular exercise is recommended, particularly in post-menopausal women.

Hormone replacement therapy (HRT) involves the administration of an oestrogen / progesterone / testosterone combination, in addition to adequate calcium intake and weight bearing exercise, to post-menopausal women. It is used to overcome the problems of menopause such as hot flushes, night sweats, fatigue, aches and pains, bladder problems, and emotional problems. HRT using oestrogen has been strongly suggested to lower the risk of heart disease by about 40%. Falls in testosterone levels have also been implicated in the loss of libido of menopausal women with testosterone supplementation improving sexual desire when oestrogen alone does not.

It has recently been suggested that menopausal female masters athletes should be encouraged to take oestrogen to relieve the above-mentioned menopausal problems while testosterone replacement may restore libido, improve energy levels, prevent bone loss, and deal with the breast soreness attributed to oestrogen. The ethical problem facing masters sports administrators is that testosterone is a banned IOC drug for younger athletes. Interestingly, the use of testosterone therapy for the "male menopause" has been discussed and advocated in National Masters News, the official world and US publication for masters track and field. Until further research is done on the effects of HRT on female masters athletes and their performances, it is difficult to draw conclusions on this treatment.

EXERCISE AROUND MENOPAUSE

The ability to improve endurance fitness and lose body fat does not appear to be dependent on menopausal status. For example, a 1992 study of aerobic capacity in female masters runners (35-70 years) showed that reductions in VO2max from pre- to post-menopause was attributed to age-related changes in functional capacity and decreases in training load rather than changes in menopausal status per se.

Training studies on menopausal women have shown that improvements in aerobic capacity are possible provided the principles of overload (working progressively harder) are adhered to. As with younger athletes, the training program should commence at moderate intensity and progress gradually in intensity, frequency and duration. The risk of injury is of primary concern. Therefore, appropriate activities for menopausal women beginning to exercise include low impact aerobics, walking, cycling, swimming, aquarobics, and circuit weight training under supervision.

DRUGS AND THE MASTERS ATHLETE

Drug testing in younger athletes was introduced for two reasons. Firstly, some drugs endangered the health of the athletes; and secondly, because many drugs were performance enhancing which contravened the spirit of fair play and equal competition.

The growth and increasing competitiveness of masters sport has lead to the suggestion that drug testing may become an institution within our ranks. The dilemma facing masters sports administrators is that many IOC banned drugs are prescribed or regularly used by masters athletes for health maintenance or treatment of diseases. However, in most cases where a product contains a banned drug, there are alternative drugs to treat the problem. If in doubt contact the Drugs in Sport Hotline on 008-020506 then discuss your therapy with your family doctor or sports physician.

In 1991 the Australian Sports Drug Agency (ASDA) was established to provide both education programs on the drugs in sport issue and to conduct independent testing of Australian athletes. However, its primary focus is at the elite and open level of competition. At the recent World Masters Games in Brisbane, 1994 the Board of Directors of the games insisted on drug testing through ASDA and developed the following position statement:

> ***"World Masters Games condemns the use of performance enhancing substances as potentially dangerous to health, contrary to the ethics of sport and incompatible with the philosophy of Masters Sport."***

The drugs listed as banned substances by the IOC were adopted by the World Masters Games. However, the games organizers also stated that any masters athlete who tested positive and who had a medical certificate from a qualified medical practitioner may refer that certificate to an appointed tribunal hearing or provide evidence that the use of the banned substance was for therapeutic and / or medication purposes only. The games organizers also informed competitors that they should not cease medication to compete in the games.

The 1995 VicHealth Australian Masters Games drugs policy states that the organizers view the use of drugs as:

> ***"detrimental to sport and the spirit of the Australian Masters Games."***

While these organizers are not organizing random drug testing, they reserve the right of ASDA or individual sports to conduct their own testing at their own expense. The games organizers also state that they will recognize the sports imposed sanctions and may retrieve awards and ban guilty competitors from further participation at those games.

The following groups of drugs have been banned:

1. **Stimulants** that act on the central nervous system to increase alertness, possibly increase aggression, and elevate heart rate. These include caffeine (see nutrition section), cocaine, amphetamines, Sudafed, Orthoxicol, Actifed, and Demazin.
2. **Anabolic steroids** are artificial versions of the hormone testosterone that helps build muscle and aid recovery from both training and injury. Examples include Deca-Durabolin, Stanazol, and Primobolan.
3. **Diuretics** help the body lose water and salt, thus causing weight loss and making the urine so weak that other drugs may not show up in a drug test. Examples are Lasix and Aldactone.

4. **Narcotic analgesics** decrease the amount of pain felt from injuries or illness, thus allowing the athlete to maintain training or competing. Examples are Palfium and Di-gesic, Codeine, Panadeine. Codral, and Dymadon.

5. **Peptide hormones and analogues** that act as chemical messengers in the body. Examples are human growth hormone, human chorionic gonadotrophin and corticotrophin, all of which are responsible for growth in the human body. Athletes may use these hormones to increase size and strength of muscles or spare glycogen as an energy source.

6. **Blood doping** involves removing blood several weeks before competition and then replacing it 5-7 days before competition to increase the number of red blood cells and therefore oxygen carrying capacity of the blood.

7. **Beta-Blockers** are cardiac medications most often used to treat high blood pressure by reducing heart rate and reducing fine tremor, thus resulting in a "steadier hand". In sports such as pistol shooting and archery these drugs can have obvious benefits. Examples include Betaloc, Inderal, Lopresor, and Tenormin. These drugs should not be stopped suddenly unless on doctors advice.

RECOMMENDED READING

1. Kerlan, R.K. (Ed). (1991) **Sports Medicine in the Older Athlete**. Clinics in Sports Medicine Series. WB Saunders, USA. ISBN 0278-5919. Cost: $60-70.
2. Levy, A.M. & Fuerst, M.L. (1993) **Sports Injury Handbook.** Wiley & Sons, USA. ISBN number 0-471-54737-9. Available from Jacaranda Wiley, PO Box 174, Nth Ryde NSW 2113. Cost: $35.
3. Sports Medicine Australia. **Safe Veterans Sport: Guidelines for safe participation in veteran's sport.** ISBN number: 1-875334-05-X. Available from Sports Medicine Australia, PO Box 897, Belconnen, ACT 2616. or your state branch of SMA. Cost: $10.
4. Sutton, J.R. & Brock, R.M. (Eds) **Sports Medicine for the Mature Athlete.** Benchmark Press, USA. ISBN number: 0-936157-04-6. Cost: $70-80.

CHAPTER 7
EXERCISE IN EXTREMES OF TEMPERATURE

Not all of us live in the home of the Sheffield Shield for 1995 - sunny south-east Queensland where the weather is fine one day and perfect the next. Many masters athletes have to train and compete in hot, humid conditions or the cold winters of southern Australia or elsewhere. The purpose of this chapter is to examine the body's responses to exercise in both hot and cold conditions, what changes occur in these responses with age, and how the masters athlete can maximize performance in these extremes of climate.

TRAINING AND COMPETING IN THE HEAT

For years it has been thought that the aging process is accompanied by a decreased ability to effectively regulate body temperature while exercising in the heat. This belief has been perpetrated by the observation that older people suffer heat injuries or death during climatic heat waves. Furthermore, many laboratory studies have shown that older, untrained men and women respond to heat stress with higher body temperatures, higher heart rates, lower sweat rates, and greater loss of body fluid than younger people.

When we exercise in the heat, we generate large amounts of heat. There are two major mechanisms by which we lose this heat. Firstly by increasing skin blood flow we take heat away from the body core to the skin. The second mechanism of heat loss is producing, and more importantly evaporating, sweat. The evaporation of the sweat is the major avenue of heat loss from our bodies to the environment.

A number or recent studies at Pennsylvania State University in the USA examined a group of 55-70 year old male and female endurance athletes and compared their responses to exercise in the heat with younger athletes matched for aerobic fitness level, body size, and body fat. The major finding was that the older athletes generate the same body heat as the younger athletes, thus suggesting that we the older athlete respond to heat better than older non-exercisers. However, the same researchers found that the older athletes had a 25-40% lower skin blood flow and that while the older athletes activated the same number of sweat glands, each sweat gland had a significantly lower sweat output compared to the younger athletes. These findings strongly suggest that the older athlete needs to take care when exercising in the heat.

Can the older athlete acclimatize to the heat? The research suggests yes. In 1988, a study was undertaken that matched a group of middle aged male runners (46±5yr) and a group of 20-year-old runners. The researchers heat acclimatized both groups the same way and observed no age-related differences between the athletes in their response to running in the heat. Whether the same response would be observed in 60 plus year olds remains to be seen.

Each of the heat studies above observed great variability in each of the older athlete's response. The researchers strongly suggested that, regardless of age, the level of aerobic capacity (VO2max), acclimatization, and hydration level of the individual athlete are far more important in determining successful ability to exercise in the heat than age itself.

However, the following guidelines are strongly recommended for the masters athlete when exercising in the heat:

1. **Acclimatize.** Most heat-related injuries occur during the first few exercise sessions in the heat. Shorten the duration or lower the intensity of the session for the first few days. Research suggests 8-10 days to acclimatize.
2. **Fluid Replacement.** Drink as much fluid as tolerable 30-45 minutes before training or racing. Drink a cupful of fluid every 15 minutes during exercise. After exercise, drink more fluid than the amount that quenches your thirst, eat meals high in water content (fruit and vegetables), and to replace the sodium lost in sweat, a sports drink such as Gatorade, Isosport, or Powerade (see Nutrition section for details on sports drinks) is recommended during and after exercise longer than one hour. Drinking water alone during exercise may lower the concentration of electrolytes in the blood which may lead to a reduced desire to drink, thus not restoring our blood volume lost through excessive sweating.
3. **Use common sense.** If you are concerned that it's too hot to exercise at a certain time of the day, it probably is. Train in the

early morning, late evening, or go swimming or water running instead.

4. **Maintain a high aerobic fitness level.** Research has shown that the best predictor of heat intolerance in older athletes exercising at a given pace is aerobic capacity.

5. **Know the early warning signs of heat injury**. Primarily due to dehydration and less often salt depletion, the warning signs are light-headedness, dizziness, headache, nausea, chills and profuse sweating. Slow down, stop, get to a well-ventilated shaded area and drink cool fluids.

6. **Pay attention to health status or use of prescription drugs.** Diabetes and hypertension can lower the ability to exercise in the heat. Some prescription drugs (diuretics, vasodilators, adrenergic blockers, anticholinergics) may affect the ability to tolerate exercise in the heat. Ask your family doctor or a Sports Physician if in doubt.

TRAINING AND COMPETING IN THE COLD

Many masters athletes live and train in a cold climate. Indeed, even sunny Queensland experiences mid-winter cold when the temptation on a Sunday morning is to pull the bedcovers up and forget that long run. Firstly, this section will examine the mechanisms of heat loss in a cold environment, then examine how age affects these mechanisms, and finally make recommendations on how the masters athlete can prevent injury when training in the cold.

Heat is transferred from a higher to a lower temperature. Normal body temperature is 37°C with skin temperature 31°C. If the air or water temperature is less than 31°C, heat will be lost from the body. The amount of heat loss will depend on a number of factors:

- the air or water temperature - *the colder the temperature, the greater the heat loss.*
- the amount of body fat - *the higher the body fat, the less the heat loss.*

- the wind velocity - *the stronger the wind, the greater the heat loss.*
- the athlete's body surface area - *taller, thinner people have a greater surface area per kilogram of body weight and are more susceptible to cold.*
- the age of the athlete - *older groups have less ability to cope with cold.*
- the athlete's fitness level - *the fitter the athlete the greater the ability to produce more heat during exercise.*
- the intensity of exercise - *the slower we exercise, the less heat produced.*
- the amount of external insulation - *layers of clothing, swim cap, grease, or wetsuits hold heat into the body.*
- the duration of the exercise - *the longer the more the risk.*
- gender - *females generally have lower VO2max values than males and a higher surface area-to-mass ratio. Thus, despite the greater body fat stores, they are generally more susceptible to cold injury.*

Exposure to the cold causes two major responses. Firstly, heat generation through shivering raises the resting metabolic rate (heat production) by three or more times. This mechanism is bought on by both decreases in both skin and core (body) temperature. Decreases in both these areas stimulate the second response to cold - vasoconstriction or narrowing of the blood vessels, particularly those below the skin. This decreases skin blood flow and increases the insulating effect of the body tissues. In addition, warm blood is redirected to the deeper tissues which promotes heat conservation because the deeper veins of the arms and legs lie close to the major arteries. The heat from the warmer arteries can then warm up the cooler veins. However, the narrowing of blood vessels which occurs in the arms and legs does not occur in the surface vessels of the head. This means that up to 25 percent of the total heat loss to the air or water can occur from the head. This is the reason why woollen hats or bathing caps are strongly recommended when exercising in cold air or water.

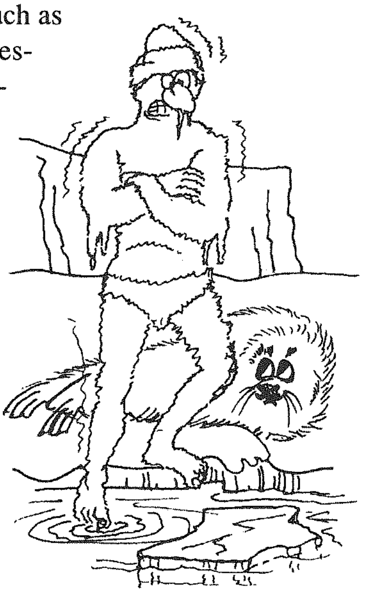
Recent research in Canada compared exercise responses to the cold (5°C) in eight young adults (26.5±2.6yr), eight well-trained older athletes (59.5±3.4yr) matched with the youngsters for aerobic capacity, and 11 untrained seniors (63.5±4.0yr). They observed a greater rate of decrease in body temperature in the older groups compared to the youngsters. They suggested that the older groups had a lower resting metabolic rate (heat production) and a decreased ability to vasoconstrict their blood vessels compared to the younger group. It thus appears that the older athlete has a decreased ability to preserve heat in the cold, thus making us more susceptible to cold injuries than younger athletes.

Exercise in the cold has been shown to lower both aerobic capacity (VO2max), muscular strength and power and thus speed. The slower speed has been suggested to be due to a slowing of energy production, slowing of the nerve conduction velocity, and increased tissue viscosity or stiffness. However, endurance exercise in the cold may be enhanced by cool environmental temperatures or by treatments such as brief, pre-exercise cold water immersions, cold showers, or cold packs. This is probably due to maintenance of the all-important muscle blood flow in cold conditions where the demand for skin blood flow is low.

While it has been well documented that we can acclimatize to the heat, no such evidence exists that we can do the same in the cold. However, it might be suggested that continuous exposure may lead to increased narrowing of the skin blood vessels, increased insulation secondary to increases in body fat, or that our resting metabolic heat production increases after prolonged exposure to the cold.

SWIMMING IN THE COLD

Swimming in cold water, particularly for older swimmers, is worthy of discussion. The ideal water temperature for swimming is 26-28°C. Wetsuits should be worn in water 20°C or below and no swim events should be held if the water temperature is 16°C or below (FINA rules). For the exercising masters athlete at risk of coronary heart disease, even greater caution is needed in the cold. As noted above, the cold causes blood vessels to constrict. This narrowing of the blood vessels raises blood pressure, thus causing the heart to work harder and need more oxygen. However, the blood vessels carrying blood and oxygen to the heart may also constrict and reduce oxygen delivery to the heart, thus causing chest pain, and the likelihood of a heart attack. Research has shown that arm work such as swimming has a greater effect on raising blood pressure than leg work. Thus, masters swimmers, particularly those at risk, should take extra caution in water below 24°C.



However, if you must swim in cold water, the following advice is given:

- wear a wetsuit if possible.
- wear a bathing cap or two since great deals of heat are lost from the head.
- cover the body (especially the neck, groin and armpits) in grease or vaseline.

- if you experience symptoms of cold injury - shivering, numbness, weakness, paleness, remove yourself from the water and warm up.
- stay as active as possible to generate heat. Longer swims with short intervals are thus recommended.

With the special considerations for masters swimmers noted above, the following guidelines are strongly recommended for the masters athlete when exercising in the cold:

1. **Correct warm-up.** In cold conditions, particularly for speed and power events, warm-up may require wearing heavier clothing, exercising and stretching for longer and / or more intensely, and warming up immediately before the event.
2. **Wear appropriate clothing**. The goal is to provide adequate insulation while avoiding accumulation of sweat. Multiple layers are suggested. The innermost layer should carry moisture away from the skin (polypropylene or cotton fishnet materials). The middle layers should include good insulation materials such as down or synthetics. In windy or rainy conditions the outer layer should be water and wind resistant. Zippered clothes are excellent in that they insulate at the start of exercise but can be opened up to allow heat loss as we warm-up. Again, proper head covering is a must. Similarly, the ears, fingers, and toes need to be protected.
3. **Gauge the wind.** Wind direction can affect comfort in the cold. Runners, cross-country skiers, kayak or ski-paddlers are well advised to "head out" facing the wind and to "come home" with the wind. This avoids the high wind chill while wearing sweat-soaked clothes.
4. **Avoid rapid cooling after exercise**. Add clothing soon after finishing a cold weather endurance event, get out of the wind, and find a warm spot in the sun.
5. **Awareness of the signs of cold injury**. Early signs are weakness, fatigue, and decreased shivering rate then followed by collapse and unconsciousness.

CHAPTER 8
NUTRITION AND THE MASTERS ATHLETE

The nutritional needs of the masters athlete involve meeting the physiological requirements of both exercise and aging, promotion of weight control, and incorporating dietary practices that reduce the risk of chronic disease such as osteoporosis and coronary heart disease.

Surveys of younger male and female athletes have suggested that their food consumption practices are proportionally similar to national averages, except that they consume more calories. However, like their non-exercising counterparts, athletes are consuming too much fat and protein and not enough carbohydrate. Of the major nutrients examined in the surveys, athlete intakes of iron, B-group vitamins, and zinc and calcium are less than the recommended daily allowance. A similar study was undertaken on 60 non-exercising men and women aged 45-75 years by the University of Toronto. The men showed few deficiencies. However, the 30 women had less than optimal intake of vitamin A, riboflavin and thiamin while both men and women had a lower than recommended calcium intake. Together, these findings would suggest the possible need for multi-vitamin / mineral supplementation in masters athletes undertaking heavy training, particularly those trying to lose weight by reducing totally caloric intake. However, definitive data on the dietary deficiencies of the masters athlete is unavailable.

GENERAL NUTRITION PRINCIPLES

Nutritional needs of all adults include energy (adequate calories), macronutrients (carbohydrate, protein, fat), vitamins, minerals, and water.

a) **Calories.**
The balance between energy intake and expenditure is a key component of long term weight control. Masters athletes expend larger amounts of energy compared to non-exercising older people, due to both their training output and their increased muscle mass. However, restricting calorie intake is a useful method of reducing body fat, particularly in competitive masters athletes who want a high power-to-weight ratio (jumpers, sprinters) or leanness to enhance performance (cyclists, runners, team players). Caloric intake generally decreases with age due to both a decrease in activity levels and a decreased muscle mass. The average young

adult's diet in the USA provides 1700 and 2700 calories per day for females and males, respectively. These figures decline to approximately 1400 and 1800 calories per day in those over 75 years of age.

One of the most commonly used formulas for estimating caloric needs are based on height, body weight, and age. One example is the Harris-Benedict equation:

Women: BEE = 655.1 + 9.56 (W) + 1.85 (H) - 4.68 (A)

Men: BEE = 66.47 + 13.75 (W) + 5.0 (H) - 6.76 (A)

where BEE = Basal energy expenditure (Calories), W = weight (kg), H = height (cm), and A = age. To estimate total daily expenditure without training, multiply BEE X 1.3 since the BEE does not account for walking, lifting, showering etc. As a masters athlete, you will also need to add on exercise calories (see table below). A caloric deficit of 3500 Calories leads to the loss of one pound of body fat, which can be safely achieved in one week by a daily deficit of 500 Calories.

Activity	Cals / minute	Activity	Cals / minute
Basketball	9.8	Running	
		5 min / k	14.8
Canoeing	7.3	4 min / k	17.9
Cycling	12	Squash	15.1
Hockey	9.5	Swimming	11.5
Football	9.4	Tennis	7.7
Golf	6	Volleyball	3.6
Judo	13.8	Walking	5.7

TABLE 1.
Estimates of Caloric expenditure in sports activities to 70 kg person.

b) Carbohydrate

The current dietary recommendations for athletes are similar to those recommended for the general population. Carbohydrates should contribute 50-60%, proteins 10-20%, and fats should be restricted to 30% of total calories. However, masters athletes involved in strenuous, prolonged endurance training should increase carbohydrate intake to 60-70% at the expense of fats.

The purpose of the high-carbohydrate diet is to maximize carbohydrate stores (glycogen) which is the primary muscle fuel during high intensity exercise. Consistent consumption of a high carbohydrate diet promotes glycogen restoration, particularly if the carbohydrate is taken within the first 30 - 120 minutes after exercise and has a high glycemic index (GI). The glycemic index measures the extent to which blood glucose is elevated above resting levels for a period of time after eating a food containing 50 grams of carbohydrate. High GI foods enhance the recovery of muscle glycogen. Masters athletes should consume at least 50 grams of high- to moderate-GI carbohydrate as soon as possible after exercise. They should then eat or drink at least an additional 50 grams every two hours until they eat a large meal. Four hours after exercise the most important factor for glycogen resynthesis is the total amount of carbohydrate consumed rather than the GI.

HIGH GI (>85)	MODERATE GI (60-85)	LOW GI (<60)
Glucose (4.2 tbsp)	Rice (1 cup)	Apples (2.4)
Sugar (4.2 tbsp)	Oatmeal (2.1cups)	Dates (8)
Bread (3.5 slices)	Pasta (1.5 cups)	Figs (5)
Potatoes (1)	Grapes (3.1 cups)	Peaches (5)
Sweet Corn (1.2 cups)	Oranges (3)	Pears (2)
Honey (2.8 tbsp)	Sweet potato (1.3 cups)	Plums (5.6)
Bagels (1.6)	Baked Beans (0.9 cup)	Beans (1.5 cups)
Raisins (0.4 cup)		Lentils (1.2 cups)
Watermelon		Yoghurt (2.8 cups)
Lucozade		Milk (4.3 cups)
Lollies		
Weetbix		
Cornflakes (2 cups)		

TABLE 2.
Carbohydrates that have a high-, moderate-, or low-glycemic index (GI). The figures in brackets are the amount required to yield 50 grams of carbohydrate.

Low glycemic index foods consumed an hour or so before exercise may prolong endurance time by providing a slow-release source of glucose within the blood during prolonged exercise. A recent study undertaken at the University of Sydney had eight trained cyclists pedal to exhaustion at a moderate intensity, one hour after eating either lentils (low GI), potato (high GI), glucose (high GI), or water. Endurance time to fatigue was 20 minutes longer after the lentil meal than the potato meal.

c) **Proteins**

The recommended dietary allowance of protein for adults is 0.8

FOOD	SERVING SIZE	PROTEIN (gms)
Whole milk	1 glass (200ml)	6.5
Skim milk	1 glass (200ml)	6.5
Low fat milk	1 glass (200ml)	8.0
Yoghurt	1 carton (200ml)	11.0
Low fat yoghurt	1 carton (200ml)	14.0
Cottage cheese	30gm	3.5
Hard cheese	30gm	7.0
Eggs	1 (60gm)	7.0
Beef, veal, lamb, pork	100g cooked	27.0
Kidney/liver	100g cooked	26.0
Fresh fish	100g cooked	22.0
Tinned fish	100g cooked	20.0
Crabs, lobster, prawn	100g cooked	22.0
Chicken	100g cooked	27.0
Bread	1 slice	2.5
C/flakes, r/bubbles, w/bix	30gm or 1 biscuit	2.0
Muesli (Natural)	30gm	4.0
Rice (steamed)	1 cup (150gm)	3.0
Pasta	1 cup (150gm)	6.5
Potatoes	1 medium	2.0
Beans	Half a cup	5.0
Avacado	Half a medium	6.0
Most fruit	1 large	1.0
Big Mac	1 large	30.0

TABLE 3.
Protein content of common foods.

gram / kg body weight per day. For example, a 70kg man would achieve this by consuming 56g protein per day which is easily achieved in the western diet. The unnecessary use of protein supplements and overemphasis on high protein foods (that may be high in saturated fats and cholesterol) among athletes has been a concern of dieticians and sport scientists for years.

Recent research suggests that the protein needs of athletes are likely to be higher than those of non-athletes. This is due to increased muscle breakdown, increased use of protein as a fuel, and the use of protein to make glycogen. Thus, the recommendations for athletes are 1.0 to 1.5 grams / kg per day. However, the majority of masters athletes whose diets include beef, chicken, fish, eggs, dairy products, or cereals easily meet this requirement.

Older athletes who consume mainly fruit and vegetables risk inadequate protein intake to meet the demands of exercise. Popular low fat diets such as the Pritikin diet that encourage near-abstinence from animal products are not recommended for masters athletes.

d) Vitamins

Research suggests that at least 40% of the adult population use vitamin and mineral supplements on a daily basis. Healthy adults who consume a varied diet are unlikely to need those supplements. While vitamins are touted as performance enhancers by the manufacturers, controlled studies have failed to support performance enhancement with vitamin supplementation. However, multi-vitamins may be indicated for older athletes who are on a low calorie diet to lose fat weight, pregnant or lactating women, or athletes on a strictly vegetarian diet.

Ensuring adequate dietary sources of vitamin D (eggs, butter, margarine) and B-12 (meat, dairy products, oysters) may be more crucial among older adults due to age-related changes in metabolism. Of concern to the female masters athlete is the fact that diets low in Vitamin D have been linked to increased risk of osteoporosis.

Increased carbohydrate metabolism such as that observed in athletes increases the need for the B-group vitamins that are used in energy production. Increased sweat and urine losses may also increase the loss of vitamin C. However, a well-balanced diet appears to contain adequate amounts of both these vitamins. In the absence of a diagnosed vitamin deficiency, the influence of increased intakes of vitamin supplements on performance has been poorly substantiated.

Vitamins A, C, and E have been recently termed anti-oxidants which are believed to neutralize harmful free radicals which can attack our immune system and make us more susceptible to infection and illness. These free radicals are caused by pollution such as smoking, exhaust fumes, and hard exercise. Recent research has suggested that moderate exercise stimulates the immune system while large volumes of training may suppress the immune system, making us more vulnerable to colds, flu and other viral infections. Recent Australian research has suggested that intake of vitamins A, C, and E (see table 4 below) may help remove free radicals.

Vitamin A	Vitamin C	Vitamin E
Mango	Oranges	Cooking oils
Rockmelon	Kiwi fruit	Asparagus
Watermelon	Strawberries	Avocado
Avocado	Grapefruit	Blackberries
Corn	Rockmelon	Green leafy vegetables
Carrots	Mango	Nuts
Pumpkin	Brussels sprouts	Rolled oats
Spinach	Broccoli	Rice bran
Sweet potato	Cauliflower	Eggs
Tomato	Red capsicum	Alfalfa seeds

TABLE 4.
Foods high in anti-oxidant vitamins

e) **Minerals**

The losses of iron, magnesium, and zinc via urine and sweat are associated with an increased requirement for these nutrients in masters athletes. However, as with vitamin supplementation, in the absence of diagnosed mineral deficiency, the influence of increased intakes of mineral supplements on performance has been poorly substantiated.

The iron status of athletes has been a focus of research because of the adverse effect of iron deficiency on endurance performance. Because of increased iron losses in endurance athletes, the daily iron recommendation is almost double that recommended for men and postmenopausal women (7-10 mg/day) and premenopausal women (12-16 mg/day). If dietary intake is adequate, iron (liver, beef, oysters, green leafy vegetables), zinc (meat, eggs, wholegrain products), magnesium (wholegrain products, green leafy vegetables) and copper (meat, fish, vegetables) status can be maintained in spite of intense training.

Calcium is an important mineral in the diets of masters athletes due to its relationship to bone density and the risk of osteoporosis. Reduced bone mass is associated with increased risk of stress fractures and other athletic injuries in addition to osteoporosis, so ensuring adequate calcium intake (see table 5 below) is important for the older athlete. Among premenopausal women, low calcium diets that are also restrictive in calories and fat appear to contribute to athletic amenorrhea (loss of menstrual cycle) and the associated bone loss. Calcium balance studies suggest requirements of 1000mg / day for postmenopausal women, 1200 mg /day for pregnant / lactating women and 800 mg / day for premenopausal women and men.

FOOD ITEM	AMOUNT	CALCIUM (MG)
Yoghurt	1 cup	415
Ricotta cheese	1/2 cup	337
Skim milk	1 cup	302
Ice cream	1 cup	151
Full cream milk	250ml	300
Cheese	30g	240
Sardines with bones	100g	350

TABLE 5.
Calcium content of selected foods.

NUTRITION AND THE REDUCTION OF CHRONIC DISEASE RISK

Another objective of the good dietary practice in the masters athlete is to reduce the risk of disease. Poor nutrition or an unbalanced diet appears to be a major contributing factor to coronary heart disease, high blood pressure, type II diabetes, certain cancers, bowel disorders, iron-deficiency anaemia, and dental decay. In 1992, the Nutrition Committee of the National Health and Medical Research Council of Australia published a list of dietary guidelines for the general population which are applicable to masters athletes.

1) **Enjoy a wide variety of nutritious foods.** Consuming a variety of foods from the range of the five food groups (see table 6 below).

Group	Type of food	Serves/day	Examples
Milk Group	milk, cheese, cream butter, yoghurt	2 +	300-600ml milk
Meat and alternatives	meat, fish, eggs nuts, beans	2 +	150g lean meat 5 eggs, 90g nuts
Fruit and vegetables	citrus fruit, green vegetables, fruits, yellow vegetables	4 +	1 piece = 1 serve 1/2 cup = 1 serve
Bread and cereals	Bread, cereals, rice pasta.	4 +	4 slices of bread 3/4 cup cereal 1 1/3 cup rice, pasta
Butter and margarines	Butter, margarine	1 serve	1/2 tablespoon

TABLE 6.
The five food groups

2) **Eat plenty of breads and cereals** (preferably wholegrain), vegetables (including legumes) and fruits. These high complex carbohydrate foods should be a major component in the diets of athletes. The complex carbohydrates restore muscle glycogen (carbohydrate) stores depleted after training and contain more fibre, minerals and vitamins (especially B-complex and iron).

3) **Eat a diet low in fat and, in particular, low in saturated fat.** Diets high in saturated fat are associated with elevated blood cholesterol, triglycerides, and low density lipoprotein (LDL) and the consequent increased risk of heart disease and atherosclerosis. While endurance exercise may lower total cholesterol and elevate high density lipoprotein (HDL) (the "good" cholesterol), athletes are encouraged to minimize fatty foods for other reasons. In particular, to ensure carbohydrate is adequate, and to increase the emptying of the stomach which is slowed with consumption of fatty foods.

4) **Maintain a healthy body weight** by balancing food intake and regular physical activity. Excess body fat in the masters power athlete lowers the power-weight ratio while in the masters endurance athlete who has to carry body weight over a long distance, those extra kilograms act as bricks to decrease endurance performance. Some athletes, such as light-weight rowers, may need to 'make weight' in order to compete and may compromise strength and health by undertaking unrealistic weight loss practices such as radical dieting or dehydration. A safe rate of weight loss (0.5 - 1.0 kg of fat per week) allows for weight loss and a balanced dietary intake to be maintained.

5) **If you drink alcohol, limit your intake.** In most masters sports, the social side of the sport is a priority. In some sports alcohol consumption is often admired in the name of camaraderie and team spirit. However, alcohol and sports performance do not mix. While most masters athletes are aware of alcohol's damaging effects on the liver and nervous system (slowed reactions, reduced co-ordination), alcohol may also reduce strength, power, endurance, as well as impair the ability to regulate heat. In the exercise recovery phase (post game or training), alcohol slows the rate of muscle glycogen (carbohydrate) regeneration and aggravates dehydration. Alcohol is also a powerful vasodilator (blood vessel enlargener) which can increase bleeding and swelling after injuries or bruising, thereby lengthening recovery. While it might be argued that alcohol is a high carbohydrate source, it is very low in nutrients such as vitamins and minerals.

6) **Eat only a moderate amount of sugars and foods containing added sugar.** A number of recent studies have suggested the importance of simple carbohydrates (sucrose, glucose, polycose) for enhancing recovery in the two hours following training or competing. However, athletes should be discouraged from relying heavily on these sugars in their general training diet since they contain little or no vitamin or minerals.

7) **Choose low-salt foods and use salt sparingly**. There exists a popular belief that masters athletes, particularly endurance athletes from hot climates, lose excessive salt through sweating. However, such athletes who follow low-salt diets rarely suffer a deficiency of sodium. One adaptation to exercise in the heat is a reduction in the sodium content of the sweat with acclimatized athletes having about one-third the sodium sweat concentration as unacclimatized athletes or untrained people. Furthermore, with excessive sodium loss in sweat, the concentration of the hormone aldosterone increases which makes the kidneys conserve sodium. The use of

salt or salt tablets as a treatment for cramps has no scientific basis while excessive intake of salt can exacerbate dehydration.

8) **Drink more water.** Water is an important consideration before, during and after training, particularly for the endurance or team athlete from hot climates. Measuring nude weight before and after training (1kg loss = 1 litre of fluid) is a useful indicator of fluid loss.

9) **Eat foods containing calcium**. This guideline is particularly important for both the pre- and post-menopausal female masters athlete. Menstrual dysfunction such as amenorrhea (loss of periods) has been shown to be higher in female athletes than the general population. Calcium requirements in these athletes may be higher than menstruating athletes because of increased loss of calcium in the urine. Reduced bone density is also linked to both low-calcium intake and low oestrogen levels such as those observed in post-menopausal women or pre-menopausal women with menstrual problems.

10) **Eat foods containing iron.** This is particularly important to pre-menopausal women, vegetarians, and endurance athletes. A high rate of iron loss and low body iron stores (serum ferritin) are frequently reported in both male and female endurance runners. Daily dietary intakes of 23 mg per day for normally menstruating women and 17.5 mg per day for men and post-menopausal women appear to meet these losses in distance runners. Dietary sources of iron include liver, beef, oysters, cereals, and green leafy vegetables. Meat, seafood, and poultry sources are preferred sources since their rate of absorption is greater than iron found in cereals or vegetables. An ingredient (tannic acid) of tea and to a lesser extent coffee, has been shown to reduce iron absorption rates while vitamin C and alcohol enhance iron absorption rates from vegetables and cereals.

THE PRE-EVENT MEAL

The current consensus of opinion is that carbohydrate intake within 1-6 hours prior to exercise may have a positive effect, or at worst, no effect on performance. An easily digested, high carbohydrate meal familiar to the athlete and known not to cause flatulence or diarrhoea, should be consumed, particularly before intense endurance exercise. The masters athlete should practise the intended strategies in training to be sure the eating strategy works. Masters athletes such as diabetics who are sensitive to changes in blood sugar, should avoid simple sugars (soft drinks, fruit juices, some sports drinks) prior to competition.

The following factors need to be considered when planning a pre-event meal:

1) **Carbohydrate should be emphasized.** Low glycemic index foods (see table 2 in this chapter) have been shown to increase endurance time to fatigue due to their slow breakdown. Approximately 70% of the pre-event meal should come from carbohydrate. However, the high fibre or fructose content of some foods with a low glycemic index may lead to gastrointestinal upsets in some athletes, particularly runners who are exposed to more jarring than cyclists or swimmers. Similarly, spicy foods that cause wind should also be avoided. Athletes who suffer from such upsets may benefit from commercially available liquid meals (Exceed high carbohydrate source) which provide nutrition while minimizing bowel residue.

2) **Fat and protein content kept to a minimum.** Fat has been shown to delay the process of digestion and does not contribute to liver carbohydrate stores. Protein increases water loss.

3) **Reduce salt content.** Salt has been shown to contribute to dehydration. There is no evidence to suggest the need for salt supplementation in most events with the possible exception of ultra-endurance events spanning several hours or days where some electrolyte supplementation may be needed.

4) **Increase fluid intake.** Fluid intake prior to endurance events is essential. Increased fluid intake in the 24 hours prior to competition is essential. Increased fluid intake is particularly important if combined with increased carbohydrate intake since glycogen is stored in the muscle and liver with water in a ratio of 1:3. Fluids, particularly water (500ml) are recommended 15-30 minutes prior to competition. Again, practice is essential to establish individual tolerances.

5) **Meal time and size.** The process of digestion can divert up to 29% of our heart's blood output to the gut, thus having the potential to limit blood flow and thus oxygen availability to the working muscles. Thus, consuming meals 2-4 hours prior to competition has been shown to allow the meal to be emptied from the gut and to optimize liver glycogen levels. The energy content of the pre-event meal is totally dependent on each athletes needs and comfort and the nature of the event. The suggested intake is 500-1000 Calories.

CARBOHYDRATE LOADING

Adequate carbohydrate stores are essential for endurance performance. High-intensity endurance events such as marathons, olympic distance or above triathlons, and cycle road racing place greater demands on the carbohydrate stores within the muscles and liver than most team sports or skill sports. Normal carbohydrate stores can be attained by regularly consuming 7-10 grams of carbohydrates (see Table 2) per kilogram of weight per day. The stores can be increased by tapering training leading up to competition and increasing consumption up to 10 grams of carbohydrates per kilogram of weight per day in the one to two days prior to competition. Unfortunately, most athletes do not meet these recommended intakes. Thus, the concept of carbohydrate loading is recommended by endurance athletes. This practice is capable of increasing carbohydrate storage by 200-300%, thus delaying fatigue and improving performance in events longer than 1-1.5 hours. Originally, a sports scientist named Astrand (Yes, another Scandinavian!) suggested the following approach to carbohydrate loading:

- ***7 days prior to racing:*** deplete carbohydrate stores by exhaustive long or hard exercise
- ***the next 3 days:*** low carbohydrate, high protein and fat diet and maintained training
- ***last 3-4 days:*** high carbohydrate diet with reduced training

This procedure lead to 200-300% increases in muscle stores of carbohydrate but also had a number of negative side-effects in some individuals. These included fatigue, weight loss, and irritability during the low carbohydrate phase and possible weight gain during the high carbohydrate phase. This weight gain in some athletes has been shown to be from 2-3.5 kilograms and is due to the fact that water is required to store the extra carbohydrate in a ratio of 2.5:1. While my personal experience in using this method on four occasions has produced none of the above side-effects, a modified loading regime that omits the low carbohydrate phase has been suggested.

The modified carbohydrate loading procedure omits the exhaustive exercise and carbohydrate restriction. Prior to competition, training is tapered while carbohydrate intake is increased. Specifically, training is moderate and normal diet maintained days 4 – 7 before competition. In the last 3-4 days prior to competition carbohydrate is increased and training light or non-existent. While this loading method may be of benefit, I personally feel that some quality work, albeit small in volume, is necessary in the last 3-4 days. Thus, I strongly suggest that you try each of these methods, particularly if training for a marathon, road race on the bike, or half ironman or ironman triathlon.

FLUID AND CARBOHYDRATE REPLACEMENT DURING EXERCISE

Historically, until the 1970's endurance athletes and team players weren't encouraged to replace fluids lost during training or competition. Even today, despite coach and athlete education, research has shown that the volume of fluids voluntarily replaced during exercise (500mL / hr) replaces less than half of an athlete's body fluid losses.

The decision as to how much fluid to drink should be based on a risk-benefit analysis. The risks of inadequate replacement are dehydration, heat cramps, heat exhaustion or more severe heat injury, and thus poor performance. The risks of too much fluid intake are gastrointestinal upsets and a reduced pace during competition associated with the difficulty of drinking large volumes of fluid. The benefits are reduced cardiovascular stress and reduced risk of heat injury which probably improve performance.

The primary purpose of carbohydrate ingestion during exercise lasting longer than one hour is to maintain blood glucose levels and to sustain a high rate of energy production from blood glucose and muscle glycogen (carbohydrate stores). This will allow you to race longer or sprint faster at the end of the race. The majority of research studies suggest improved performance with carbohydrate (glucose, sucrose, or starch) feedings of 30-60g per hour of exercise. (Most sports drinks contain this amount if you drink according to the table below.)

OBSERVED SWEAT RATE		RECOMMENDED FLUID INTAKE	RECOMMENDED FREQUENCY
(ml/hr)	(kg/hr)	(ml)	(min)
500	0.5	125	15
750	0.75	190	15
100	1.0	200	15
125	1.25	210	10
1500	1.5	250	10
1750	1.75	290	10
2000	2.0	330	10

TABLE 7.
Strategies for matching fluid intake with sweat loss.

Historically, it was thought that the addition of carbohydrate to solutions impaired fluid replacement due to its effect of slowing the rate at which fluids empty the stomach. However, recent research has shown that the volume of the fluid taken in is more important than the carbohydrate concentration of the drink. Practically speaking, solutions containing 6-8% (6-8 grams / 100ml) carbohydrate are strongly recommended, particularly when combined with a drinking schedule that maintains a high stomach volume. Thus, it is possible, with practice, to take in 30-60g of carbohydrate per hour and still replace 600-1250mL of fluid.

However, large volumes of fluids may cause discomfort in some masters athletes, particularly during hard races of long duration. Drinking large volumes means slowing at water stops, having the problem of breathing heavy and trying to drink while racing, and possibly having to slow down if you get a gastrointestinal upset. However, if the race is in hot, humid and windless conditions over a long duration, there is no doubt the benefits of the above fluid replacement strategies become important for not only maintaining race pace, but also preventing heat injuries. During longer, less intense events such as ultra runs or marathon swims, research has shown that fluid replacement equal to the rate of fluid loss is more effective in maintaining performance and preventing heat injury than inadequate fluid replacement.

The primary benefit of such fluid replacement during exercise is that the cardiac output (amount of blood pumped by the heart each minute) is maintained. This allows the blood flow to the skin to be increased so as to remove heat from the body. The question might be asked - is there a time interval during prolonged exercise that is more advantageous for fluid replacement? That is, should we drink early, throughout, or near the end? A recent study at The University of Texas examined young cyclists who drank one litre of fluid at either the start, at any time throughout, at 40, or 80 minutes during a 140 minute ride. None of the different methods of drinking fluids showed any advantage over the other, emphasizing the importance of volume over timing of drinking. However, during the periods without drinking, there was increased body temperature and increased heart rate, suggesting regular drinking is the way to go to prevent heat injury.

Although it is strongly recommended that large volumes of fluid be ingested to totally offset dehydration, individual athletes differ greatly in their rates of stomach emptying and therefore tolerances to large fluid volumes. It is therefore strongly recommended that you devise your own drinking schedule and practice this schedule during training.

The following guidelines will help masters athlete maintain proper hydration during training and competition:

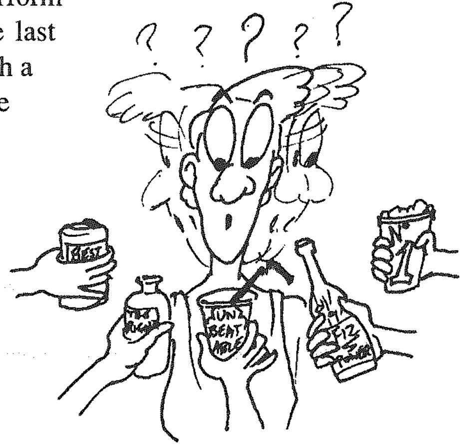
- Weigh yourself nude (wet clothes hold sweat) before and after training, especially in hot and humid weather. For each one kilogram of weight loss, drink one litre of fluid.

- Drink a sports drink containing sodium and 6-8% (6-8g / 100ml) glucose, sucrose, or maltodextrin during or after exercise to enhance fluid replenishment.
- Drink fluids (sports drink, juice, water) to tolerance 30-60 minutes prior to racing / training - have the urine clear or slightly coloured.
- Drink at least 150-250 mls (100mls = three medium mouthfuls) of fluid every 15 minutes during exercise, particularly in hot, humid and windless conditions (see table 7).
- Cool drinks are absorbed more quickly than warmer drinks.
- Avoid drinks containing caffeine (coffee, tea, colas) or alcohol because they increase urine production and add to dehydration.
- Don't let thirst be your guide - it may be too late. Research on older people suggests we have a decreased thirst mechanism. This suggests the older athlete needs to be even more aware of fluid replacement.

THE SPORTS DRINK

The supermarket shelves and television screens are filled with a vast array of sports drinks all suggesting they enhance sports performance and recovery. This section presents the latest research findings on fluid replacement and what to look for in a sports drink.

While water is an adequate fluid replacement in events under an hour in length, recent research suggests that sports drinks such as Gatorade, Exceed, Isostar, Isosport and Sports Plus taken before, during and after training and competition will enhance performance and speed up recovery. Over the last few years, we have been bombarded with a range of sports drinks all claiming one thing and another. What should we look for in a sports drink?



Firstly, the electrolytes sodium and potassium are important. Hard exercise over long duration in hot, humid and windless conditions makes us sweat. Over a long period of sweating, the volume of blood goes down as fluid is drawn from the blood to replace sweat. This increases the work the heart has to do and may reduce skin blood flow and heat loss. Significant amounts of sodium and smaller amounts of potassium are lost in sweat and need to be replaced. However, sodium has also been shown to enhance fluid absorption compared to plain water, thus helping maintain blood volume. The amount of sodium should be 10-20 mEq/L or 1-2 mEq/100ml. Masters athletes on sodium-restricted diets, in the early stages of heat acclimatization, or during prolonged, repeated exposure to exercise in the heat should place greater importance on sports drinks during and after exercise. Potassium is also important in maintaining blood volume and should be in concentrations of less than 5 mEq/L. Chloride in small concentrations may also promote fluid absorption.

The second important ingredient in a sports drink is carbohydrate. Endurance

DRINK	SODIUM (mmol/L)	POTASSIUM (mmol/L)	CHO (% - g/100ml)	CHO TYPE
Exceed	10	5	7.0	Glucose polymer * Fructose
Gatorade	23	3	6.0	Glucose, Sucrose
Staminade	10	5	3.5	Glucose
Isosport/Edge	20	5	7.0	Sucrose, Fructose Glucose polymer
Isostar	24	4	7.5	Glucose polymer Sucrose
Sportsplus	17	7.5	7.0	Glucose, Sucrose
Powerade	10	4	8	Glucose, Fructose Glucose polymer
Replace	10	5	8	Glucose, Fructose Glucose polymer

* Glucose polymer (maltodextrin) powders such as Polycose, Polyjoule, Maxim provide minimal sodium and are unflavoured.

TABLE 8.
Composition of commercial sports drinks.

exercise or high intensity exercise of short duration uses carbohydrate as a fuel. The body has enough stores of carbohydrate in muscles, liver and blood to last approximately 1.5 hours depending on exercise intensity and diet leading into the exercise. Research has conclusively shown that carbohydrate feeding during exercise improves performance. Most sports drinks contain the same number of calories, with lower calorie foods or in this case drinks, emptying from the stomach more quickly to then be absorbed in the small intestine.

Glucose, sucrose, and maltodextrins (glucose polymers or long chains of glucose) all stimulate fluid absorption in the small intestine and have been shown to provide similar cardiovascular and heat regulation responses. However, fructose (fruit sugar) is absorbed more slowly and does not stimulate as much fluid absorption as the other sugars. Furthermore, fructose has been shown not to be associated with performance improvement, possibly because it takes so long to be used as a fuel. It has also been linked to stomach upsets in exercising athletes more than the other sugars.

The carbohydrate concentration of the sports drink is important. Research strongly suggests that a 6-8% (6-8 grams / 100ml) carbohydrate solution is absorbed into the body as quickly as water, but unlike water, can provide energy to the muscles. Drinks lower in glucose concentration (<5%) have not been shown to greatly enhance performance while solutions that exceed 10% (soft drinks, Lucozade) contain minimal sodium or are often associated with abdominal cramps, nausea and diarrhoea. These high glucose concentration drinks should be drunk after exercise to help replace carbohydrate in the muscles and liver.

The third characteristic of a sports drink must be palatability. Taste, smell, feel in the mouth, and sweetness all influence how much we drink, regardless of the physiological benefits. As seen in the table below, most of the commercially-available sports drinks contain similar ingredients. Try them all during training to find out which suits your palate.

EATING AND DRINKING BETWEEN AND AFTER TRAINING OR EVENTS

Many masters sporting events consist of a number of events, a series of heats or rounds. While not eating or drinking anything may remove the risk of stomach upsets, it is essential to replace carbohydrate levels, prevent hunger, and most importantly, stay hydrated with fluids. In general, carbohydrate-drinks or water are recommended during breaks shorter than two hours and solid or liquid meals suggested during longer breaks. A study at Ball State University (USA) in the early 1980's demonstrated that 70% of a liquid meal can be emptied from the stomach in an hour with almost complete emptying within two hours. This would suggest that liquids are the preferred between-event meal.

ERGOGENIC AIDS

Ergogenic aids are those substances that are supposed to enhance sports performance. The aim of the following discussion is to present a summary of the latest scientific research into a number of the more popular "performance enhancers". While the majority of such research suggests few of these substances enhance performance, the individual experience of the athlete is just as important. If the athlete feels performance is enhanced through such aids, then that is all that matters.

It must be remembered that the supplement industry relies heavily on testimonials, scientific theories, and clever marketing strategies. However, few scientifically-controlled studies have been undertaken to conclusively show that supplementation is of benefit. There is no doubt that effective training strategies, natural talent, technology, mental preparation, nutrition and other key ingredients provide a greater influence on sports performance than dietary supplements.

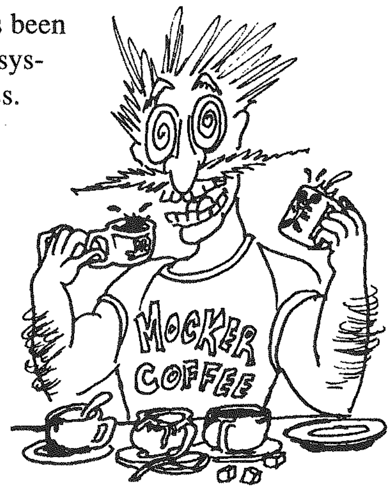
Amino acids and protein powders.

These have had a long history of use in the body-building and strength-training sports. Recently, free-form amino acids have become available commercially either singly, in combination with other amino acids, or as supplements within sports drinks or weight-gain powders. These products have been marketed on the premise that they stimulate muscle growth and strength, facilitate loss of body fat, increase the production or release of testosterone (the male hormone) or human growth hormone, provide additional exercise fuel, or improve post-exercise recovery and muscle repair.

Recent studies of protein metabolism during exercise support the need for increased protein in heavily training athletes. Current recommendations for protein intakes for endurance athletes are 1.2-1.6 g / kg / day and 1.2-1.7 g / kg / day for strength athletes. These represent about 150-200% above the amounts recommended for non-exercising Australians. However, most athletes consume high energy intakes where protein represents about 12-15% of total energy intake. This amount of protein will meet the recommendations above, without the need for supplementation. Masters athletes with low energy intakes or vegetarians may need professional assistance in the form of a sports dietician to ensure adequate protein quality and quantity.

There is little or no scientific evidence supporting positive effects on muscle growth, strength enhancement, or body fat reduction in strength-trained athletes for the following nutritional supplements: arginine, lysine, or ornithine (amino acids); ornitine alpha-ketogluterate (OKG); inosine; choline; carnitine; or chromium. The masters athlete is therefore strongly advised to ignore the fraudulent claims made by most manufacturers of nutritional supplements marketed for strength-trained athletes. If in doubt, contact a sports dietician for professional advice.

Caffeine



Caffeine is found in tea, coffee, cola drinks, chocolate, or in tablet form (eg. No Doz). Caffeine has been well documented to stimulate the central nervous system, improve reaction time, and increase alertness. Thus, it has been suggested to benefit sports such as shooting and archery. Caffeine has also been shown to benefit endurance exercise of approximately five minutes duration or prolonged exercise, although a number of studies have suggested that if the athlete is carbohydrate loaded, the benefits of caffeine on endurance are negated. The proposed mechanism is that caffeine increases the release of free fatty acids in the bloodstream. This increases the availability of fatty acids to the muscle, thus sparing muscle glycogen and promoting endurance in events longer than one hour. Caffeine has also been shown to decrease the perceived rate of exertion by possibly changing the pain threshold. However, most of the controlled studies have observed the response to caffeine to be highly variable. This strongly suggests the need for individual experimentation.

Caffeine has been listed as a banned substance above the concentration of 12 μg / mL in urine. However, this level is achieved by ingestion of 500mg of caffeine (8 cups of coffee or 17 cans of coca-cola or 12 tablets of NoDoz) over a 2-3 hour period. Now that's an addict!!

Sodium Bicarbonate and Sodium Citrate

Sodium bicarbonate (yes, the stuff used in cooking or as "Ural" in a chemist shop) is a natural buffer or neutralizer of lactic acid. Ingestion of bicarbonate and citrate will elevate the buffering capacity of the blood which leads to increased removal of lactic acid from the working muscles, thus theoretically delaying the onset of fatigue.

Ingestion of 0.3 grams per kilogram of body weight (21 grams or about 4-5 teaspoons for a 70 kg person) along with a litre of water taken 1-2 hours prior to performance, may enhance performance in high intensity events of 1-10 minutes in duration. These events include rowing, kayaking, 100-400m swims, and 400-1500m runs. It has not been shown to enhance performance in events shorter than 30 seconds or longer than 10 minutes. Performance may also be enhanced in sports which include repeated bouts of high intensity with minimal recovery time.

While bicarbonate loading in the recommended doses appears to be safe, some individuals may suffer abdominal pain, cramps, or diarrhoea. Citrate salts do not appear to cause such side-effects. As with caffeine, bicarbonate and citrate ingestion has individual effects on individual athletes. At present they are not banned substances, although their use contravenes the spirit of fair competition. Masters athletes are strongly advised to determine whether they can tolerate these buffers without the side-effects by performing a time-trial in training prior to a major competition.

Creatine

Short term (5-20 seconds) maximal exercise uses energy from a substance called phosphocreatine that is sitting in our muscles ready to act as an immediate fuel for exercise. As such, it is used in short sprints such as 100 and 200m runs or in team sports where short bursts are interspersed with short recovery periods.

A study in 1992 by Harris and co-workers reported that supplementation with creatine monohydrate increased muscle creatine levels and had its greatest effect in athletes who had initially low muscle creatine levels and in muscles that were used in training. While creatine is naturally occurring in meat and fish, cooking reduces its concentration and large (eg 1.1 kg fish) quantities are needed to obtain 5 grams of creatine per day. It is now accepted that daily ingestion of four doses of 5 grams per day will increase the concentration of phosphocreatine within muscles and will enhance the remaking of phosphocreatine during recovery. After the initial loading period of 5 days, 2 grams per day appears to maintain high muscle creatine stores.

Testimonials in the track and field literature suggest that a number of gold medal athletes from Great Britain used creatine in training for the 100-400m track races at the 1992 Barcelona Olympic Games. It is commercially available as Ergomax C150. Despite the advertising campaign undertaken by the marketers, there is no evidence to suggest that endurance exercise is improved through the use of creatine supplementation.

Carnitine

is found naturally within meat and dairy products but can also be manufactured within the liver and kidneys. Its major role is as a co-factor in the transport of fatty acids to the site of aerobic metabolism within muscle cells - the mitochondria. It has therefore been suggested that carnitine supplementation might enhance fat burning, thus enhancing endurance performance and decreasing body fat.

However, conclusive evidence that these benefits are obtained is not available. A small number of studies have suggested increases in aerobic capacity following 2-3 weeks of supplementation, while other studies have reported no changes in aerobic or power performance. While carnitine supplementation appears to be safe, it should be noted that this applies to L-carnitine preparations and not to D-carnitine.

Chromium Picolinate

Chromium has been promoted as having the ability to increase muscle mass. However, no conclusive scientific evidence exists to suggest such a claim in those athletes not suffering a chromium deficiency. However, in athletes suffering a deficiency, supplementation may be useful. Athletes at risk of chromium deficiency are those involved in regular high intensity exercise, athletes consuming a low-energy diet, and those consuming a diet high in refined carbohydrates. Chromium is found naturally in meats and vegetables.

Ginseng

Ginseng has enjoyed popularity as a health supplement for centuries. The content of the active ingredient within the ginseng root varies widely, with the content of the commercial supplements being even more variable. Ginseng has been claimed to reduce fatigue, and improve aerobic conditioning, strength, mental alertness, and recovery in athletes. However, there are few and conflicting studies to support these claims.

Bee Pollen

Claims of improved immunity and resistance to respiratory tract infections have been made about bee pollen sometimes known as Royal Jelly. However, a number of well-designed studies have failed to show improved performance following bee pollen supplementation. Several cases of allergic reactions have also been reported in some studies.

Coenzyme Q10

This coenzyme plays an important role in the biochemical process in the production of aerobic energy. It may also have a role as an antioxidant. A recent review observed lower blood levels of coenzyme Q10 in athletes compared to non-athletes and that supplementation increased these levels. Increased muscle levels were also observed in the athletes. However, no conclusive positive effect on performance has been observed.

RECOMMENDED READING

1. Burke, L. (1992). **The Complete Guide to Food for Sports Performance.** Allen & Unwin, Sydney. ISBN number: 1-86373-073-7. Available from QBD, Bookworld etc. or Allen & Unwin, 9 Atchison St., St Leonards, NSW 2065.Cost: $25-30.
2. Burke, L. & Deakin, V. (Eds) (1994). **Clinical Sports Nutrition.** McGraw-Hill, Sydney. ISBN number 0-07-470085-5. Available from McGraw-Hill, 4 Barcoo St., Roseville, NSW 2069. Cost: $70-75.

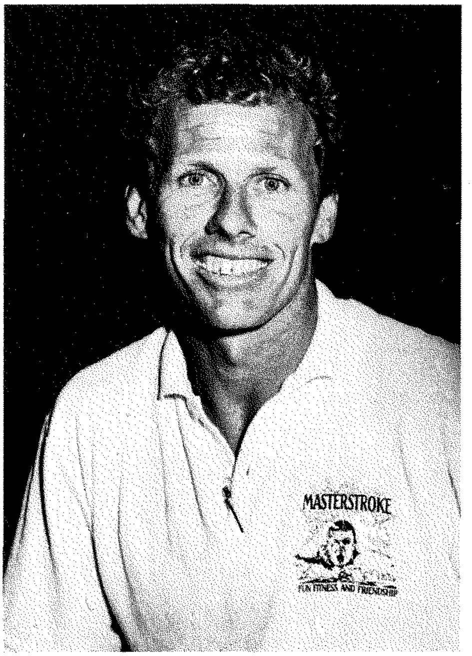
CONCLUSION

I sincerely hope you have enjoyed this book. Great effort has been made to synthesize what little sports science research that focuses on the masters athlete. I have drawn on my personal experiences as a masters athlete, tertiary and community educator, and sports scientist researching masters athletes, in completing this work. I hope this book becomes a relevant, practical, and useful book to add to your collection. Please do not hesitate to contact me with your thoughts and suggestions for the second edition.

I also hope this book goes a long way to educating the medical profession, coaches, younger athletes, and the community in general that we are different. However, I also hope that the book may change some of the prevailing attitudes in both the general and medical communities that, on the assumption of good health, we as masters athletes can train hard and long without the need to be treated as though we will have a heart attack when training or competing. Indeed, let us together show them that age is no barrier to a lifetime of fun, fitness, and friendship.

Spread the word!

Peter Reaburn PhD



Dr. Peter Reaburn PhD

Daphne Pirie...

" The tremendous growth of Masters Sport participation throughout the world thankfully is resulting in a major attitude change towards aging in Australia.

Peter's research presents Masters Athletes with the expert knowledge and confidence to prepare their bodies and achieve maximum performance. Congratulations Peter, I look forward to the second edition."

— At age 49 after a 25 year break, Daphne Pirie, former Australian Hockey Representative and Australian ranked Athlete, commenced successfully competing in Veteran Athletic events throughout the world. She has won 8 World titles in sprints, high jump and pentathlon, and set various World records.

Fred Knudson...

" There has been a lack of information on training for Masters Athletes, particularly in the area of endurance. Peter's book goes a long way toward filling this gap. It is comprehensive and easy to read. The book will assist Masters Athletes to train to maximum potential".

— Fred Knudson, aged 74, is a well known master swimmer, marathon runner and triathlete. He began training for triathlons at the age of 63. His many sporting achievements include three record breaking wins in his age group in the prestigious Hawaiian Ironman competition. In 1991, he also won his age group in the Triathlon World Championships.

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