

# CHAPTER 4

## MASTERS DIVING AND THE AGING ATHLETE

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This chapter provides an overview of biophysical changes that occur with aging that predispose this population of athletes to injury. The author describes the benefits of regular exercise that slow or reverse many changes associated with the age-related losses in strength, flexibility, balance and endurance. Aspects of diving training that reduce or minimize the risk of injury and improve fitness of participants in Masters diving are discussed.

### KEY CONCEPTS

1. Masters diving provides the aging population with opportunities for remaining physically fit and for socialization.
2. The aging process leads to a progressive deterioration in body functions and adaptive capabilities. Blood vessel walls become stiffer; musculoskeletal strength, flexibility and endurance decrease; and joints, muscles and tendons become more prone to injury. Bone mass decreases significantly in women after menopause and in men beginning in the fifth decade of life. The effects of aging, however, vary among individuals in part due to genetic make up.
3. Exercise programs can have positive effects on aging athletes. Resistance training can improve strength and forestall declines in strength and muscle for many years. Flexibility training counters the tendency for decreases in the range of motion and changes in posture and gait. Aerobic exercise has sustained benefits in reducing risks of illness and improving general fitness.
4. Due to physiological changes inherent in the aging process, injuries due to falls are a major concern in the elderly. Masters diving may provide opportunities to enhance and maintain balance and body control, thus minimizing the incidence and fear of unintentional falls among the participants.

### BUILDING BLOCKS

In recent decades, health care has improved dramatically and so has the longevity and quality of life for senior citizens throughout the world. This population needs to remain physically fit to maintain a high standard of good health. To do this, many seniors look toward activities and sports that promote fitness, create a physical and emotional challenge and also provide necessary socialization and recreation. As the elderly population continues to increase, the participation of this group in organized sports, such as diving, is also expected to grow. There are already a large number of international Masters divers with more than 250 registered in the U.S. Coaches must be prepared to address specific training and health aspects of this group of divers.

### BIOPHYSICAL CHANGES THAT OCCUR WITH AGING

Aging is difficult to define. It is a phenomenon that leads to progressive deterioration of bodily functions and adaptive capabilities. There are many structural changes which occur throughout the body systems. It is obvious, however, that there is great variability in the effects of aging among individuals.

Some people have a genetic make up combined with a healthy life-style that combats the effects of aging (Figure 1).



Photo courtesy Catherine L. Capelle

Figure 1. Betty Christian (81 years of age), 2005 Master's National Champion in the 80-90 age group; holds multiple Masters swimming and diving world records.



With aging, there is a decrease in maximum heart rate, stroke volume, cardiac output, and oxygen delivery to exercising muscle resulting in reduced cardiovascular endurance. The blood vessel walls become stiffer (thicker) with age and these changes increase blood pressure, increase the load on the heart and make the system more vulnerable to diseases such as atherosclerosis (hardening and blockage of the arteries). Atherosclerosis may lead to cardiac and musculoskeletal weakness and pain simply from the reduced blood flow to muscles. Although atherosclerosis is a cause for heart attacks, sudden cardiovascular death is rare among the elderly, especially those who are physically active.

Musculoskeletal changes occur with aging which result in decreased strength, flexibility, balance and endurance. Bone mass decreases significantly in women during menopause and in men beginning in the 5th decade of life. Aging causes a decrease in muscle mass which produces a decrease in muscle strength and endurance and a decline in basal metabolic rate. The connective tissues (muscles, cartilage, tendons, ligaments) become stiffer, making the joints, muscles, and tendon tissue more prone to injury. Regular joint loading and motion maintain muscle-tendon flexibility, strength, and endurance, articular cartilage function, and joint range of motion. Reduced physical activity adversely alters mechanical properties of cartilage. The tensile strength of ligament-bone complexes decline with age. Fractures can be devastating at any age, but in the older athlete fractures result in less impairment than changes of soft tissue responsible for restricted movement. Muscle is more easily injured by its own contraction and is repaired more slowly. Research has documented that mean muscular strength in the back, arm, and leg decreases up to 60% from age 30 to 80 secondary to progressive loss of muscle mass. This is at an average rate of 4% per decade from 25 to 50 and 10% per decade thereafter. With strength training there is less decline.

Age-related changes in the lung connective tissue lead to inefficient breathing which requires more energy. Neurological changes occur which result in gradual impairment of cognitive function, strength, sensation, balance and coordination.

It has been documented that disuse from a sedentary life-style, or from immobilization due to an injury, greatly exacerbates the changes that occur with aging. Regular aerobic, strengthening and muscle coordination exercise can significantly slow or reverse many changes associated with the age-related loss of strength, flexibility, balance and endurance.

## **MINIMIZING SPORTS INJURIES IN THE ELDERLY**

To minimize sports injuries, both intrinsic and extrinsic factors need to be addressed. Intrinsic factors are the individual athlete's characteristics: age, gender, weight, height, body composition, musculoskeletal development, and previous injuries or limiting factors. Extrinsic factors are training methods and equipment, and environmental aspects such as tempera-

ture, noise, lighting, etc. Life-style factors such as smoking, alcohol and poor nutrition effect an athlete's overall health and may increase risk of injury through muscle wasting. Medical diseases (heart disease, chronic lung disease, diabetes, and arthritis) and medication use can certainly influence training capabilities and are more pronounced in the elderly.

Many intrinsic factors can be modified through weight loss or gain, muscle stretching and strengthening, regular aerobic conditioning, balance training and proper nutrition. Some intrinsic factors such as previous injuries with restricted movement and weakness cannot be changed. Obviously these issues will effect and modify training regimes. Older adults benefit from injury prevention training that includes stretching, strengthening, aerobic conditioning, and balance activities.

Because the aging process causes connective tissue stiffness, the tightened muscles, tendons, and ligaments become less pliable, with a shortened arc of movement and force, creating postural and gait changes, and decreased joint range of motion. The most important result of these changes is the increased propensity to injury. Stretching of joints and muscle groups is imperative to improve performance and minimize injury. After all, what good is strength without sufficient range of motion to accomplish purposeful movement?

Resistance training will improve muscular strength and can forestall declines in strength and muscle mass for many years. Research has shown that aerobic training improves aerobic power and cardiovascular fitness in older individuals. Endurance exercise increases  $\text{VO}_2\text{max}$  (oxygen utilization by muscle and organ components) by 20 to 30% in the elderly after 6 months of regular exercise. Aerobic exercise has substantial benefits in reducing risks of illness and improving general fitness.

Neuromuscular changes which adversely effect balance, coordination, sensation, and strength make an aging athlete more prone to falls. Therefore, balance and movement training should be included in the athlete's program. Static balance training involves balance recovery activities (standing on one foot), whereas dynamic balance training involves slow, smooth continuous movements. It has been demonstrated that an integrated dynamic training program is more effective in lessening the incidence and fear of falling.

Musculoskeletal injuries in the elderly can include both acute and/or inflammatory overuse injuries. The most common injury is a muscle strain. Chronic overuse injuries are associated with the amount of training. Age is not a predisposing factor.

## **PRACTICAL APPLICATIONS**

### **INJURY SURVEILLANCE**

Masters divers accounted for 3% of USA Diving injuries from 1993-1996. Eighty percent of Masters divers injuries were from practice and 20% from competition. Of the Masters diving injuries reported, 57% were related to entry. Of these,



43% were associated with poor body alignment at entry. The percentage of injuries associated with entry increased by level. Fifty percent of Masters' diving injuries were related to the pike position. Notably, falls from a height were not a source of injury for Masters divers. The only fall was a non-diving slip and fall on the pool deck. The incidence of injury for Masters divers is 1.4 injuries per 100 divers or .3 injuries per 100,000 dives.

## USA DIVING MASTERS NATIONAL CHAMPIONSHIPS INJURY REPORT

The USA Diving Masters program has kept detailed records of injuries sustained at National Championships from 1978 through 1997. These events are held twice a year and include four days of practice and competition from 1- and 3-meter springboards and 5-, 7.5- and 10-meter platforms. Participants ranged from 21 to over 90 years of age (Figure 2). Injuries severe enough to cause the diver to withdraw from the competition were used for tabulation. During this time there were 14 injuries per 7980 Dive Events, or an overall risk of injury of 0.18%. A Dive Event (DE) is defined as all the practice and competition dives for each event in which a diver competes. Therefore, a diver competing in 1- and 3-meter, and platform would represent 3 DE's. The NCAA uses similar reporting methods to record data collected for their injury reports. The statistics for competition in other sports in 1996 were significantly higher than Masters diving: 19.76/1000 (1.976%) for football, 15.77/1000 (1.577%) for men's gymnastics and 21.88/1000 (2.188%) for women's gymnastics.

The Masters age group with the highest risk of injuries (0.22%) is the 35 to 49 year old group, and the age group with the lowest risk (0.11%) is the over 70 years old group.



Photo courtesy Catherine L. Capelle

Figure 2. 2005 Master's National Championships 80-84 age group medal winners (L to R)-Herb Collins-silver medalist and Tom Hairabedian-gold medalist. Tom Hairabedian was entered in the inaugural 1974 Indoor Masters Nationals in the 50-54 age group, but had to scratch due to injury. He has participated in the Masters National Championships since its inception, an exemplary model of physical fitness maintenance for the active aging athlete. Tom was Masters national chair from 1981-1984.

The most common injury was a dislocated shoulder. There was no gender difference for predilection of injury. These statistics indicate that indeed the elderly diver is not at a higher risk for injury despite physiological changes with aging. Perhaps, only the hardest, most fit athletes still compete thus reducing the risk for injury or, perhaps as the athlete ages, the difficulty level and intensity of training naturally decrease and consequently the risk of injury decreases.

## PHYSICAL PREPARATION FOR MASTERS DIVERS

Love of the sport of diving and the camaraderie of teammates motivates many Masters divers to continue to train to retain physical fitness specific to the sport (Figure 3). A supplemental physical preparation program is highly recommended for Masters divers to counter the inherent flexibility, strength and endurance losses associated with aging. Masters divers may spend periods of time away from diving with little or no training. Guidelines for a general program that includes static stretching, general and specific weight training, and general aerobic and anaerobic endurance activities are available in Chapter 8. Since abrupt changes in the training program should be avoided, considerations related to increasing volume and intensity are also addressed in Chapter 8. The physical preparation program for Masters divers should begin with a warm up. A cooling down period is particularly beneficial following aerobic activities in the elderly to help prevent cardiovascular events.



Photo courtesy Mitzi Mathews

Figure 3. Vi Cady Krahm-89, Bill McAlister-81, Patty Robinson Fulton-71 years of age. Photo taken at a Masters meet in Madura, CA in 1991 and sent by Patty Fulton to the author.



## DYNAMIC BALANCE CONTROL

Masters divers submit a list of dives for competition (Figure 4). The rules provide an age appropriate number of dives for Masters competition by age group. Diving involves height and body control from a takeoff surface into the water. One objective on every dive in the list is to maintain dynamic balance during takeoff. Moreover, springboard divers practice maintaining balance on a moving takeoff surface as the board depresses and recoils. Diving also involves water impact and dryland training landing skills.

Diving consists of activities such as warm-up, spotting or focusing the eyes on a spot, seeing and feeling to orient the body in space, flexibility to assume a tuck and pike position, and postural control that aid in balance control and fall prevention. Since diving is performed barefoot, the sport is especially suited to provide the aging athlete tactile stimulation to the feet. Training for diving enables the aging athlete to maintain strength in the ankles, feet and toes which is essential for balance control.

Divers routinely rehearse dives on the ground using slow, continuous movements to train for accuracy. Demonstrating skill simulation on the ground is an indicator of dynamic balance control and readiness for the aging athlete to perform at heights.



Photo courtesy Catherine L. Capelle

Figure 4. Masters divers retain movement confidence as they age up by training and competing at various heights. (L to R): Eric Bromberger, Pete Decroce, John Connor, Jay Goldstein.

## SUMMARY

Many Masters divers have had a lifelong training background and are aware of proper training techniques (Figure 5). They subsequently have developed the trainability to perform sport-specific movements without injury. However, it is imperative that their flexibility, strength, endurance and balance be maintained to minimize injuries and prolong quality of life. The functional capacity and rate of aging processes vary greatly among individuals and therefore, the training program must be individually designed for each athlete. Data support the safe participation of Masters divers. Regular exercise can significantly slow or reverse many changes associated with age-related loss of flexibility, strength, endurance and balance.



Photo courtesy Catherine L. Capelle

Figure 5. USA Diving masters divers and athlete representatives at the United States Aquatic Sports Convention in 2005. (L to R) *Front row:* Ron Kontura, Jr.; Masters National Chairpersons-John Deininger (1994-2000) and Catherine Capelle (2005-2006), Debrah Mynatt, and Julian Krug. *Middle row:* Ashley Rubenstein, Audra Eganolf, Cassidy Krug, Aaron Trippet, Thomas Finchum, Tori Ishimatsu, Chelsea Ale, Cassandra Cardinell. *Back row:* Nancilea Underwood Foster, Bryan Dunmire, Sean Letsinger, Steven Segerlin, Justin Wilcock, Oscar Delgado, Matt Bricker, Mitch Richeson.

## REFERENCES

- Kallinen N, Markku A (1995) Ageing, physical activity and sports injuries. *Sports Medicine* 20 (1):41-52.
- Chandler JM, Hadley EC (1996) Exercise to improve physiologic and functional performance in old age. *Clinics in Geriatric Medicine* 12:761-784.
- Evans WJ (1996) Reversing sarcopenia: How weight training can build strength and vitality. *Geriatrics* 51 (5):46-55.
- Vorhies D, Riley BE (1993) De-conditioning. *Clinics in Geriatric Medicine* 12:745-763.
- Mathews ME, Mathew SC (1995) U.S. Masters competitive diving related injuries. In RM Malina, JL Gabriel (eds): *U.S. Diving Sport Science Seminar Proceedings*. Indianapolis, IN: U.S. Diving, pp 65-73.
- Buckwalter JA (1997) Decreased mobility in the elderly: the exercise antidote. *The Physician and Sports Medicine* 25 (9):127-135.
- Perkins-Carpenter B (2001) *How to Prevent Falls, A Comprehensive Guide to Better Balance*. Penfield, New York: Senior Fitness Productions.

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