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Jack Groppel PhD & Nicholas DiNubile MD

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Tennis: For the Health of It!

Jack Groppe, PhD; Nicholas DiNubile, MD

Abstract: Tennis is a sport with numerous health benefits for individuals of all ages. It is also a tremendously effective fitness activity. Regular participants experience a wide variety of health-related physical and mental benefits, from improved cardiovascular, metabolic, and bone health to improved agility, coordination, and even stress and anxiety management. Physicians and other health care professionals can play an important role in educating patients and the public about the health benefits of tennis as well as motivating them to take up this activity as part of an overall exercise prescription. Based on the scientific evidence available, it is difficult to find an activity that offers as wide a range of overall health benefits as tennis, and individuals who take up tennis reap tremendous rewards.

Keywords: tennis; health; exercise; exercise prescription; fitness; prevention; bone density; osteoporosis; falls; psychology

Jack Groppe, PhD¹
Nicholas DiNubile, MD²

¹Human Performance Institute, Inc., Orlando, FL; ²Premier Orthopedics, Havertown, PA;

Introduction

Tennis is a lifetime sport with numerous health benefits.¹ Individuals of all ages can gain great physical and mental rewards by taking up this activity, and physicians and other health care professionals can play an important role in educating patients and the public about these benefits and motivating them to take up this activity. Sedentary behavior is dangerous, being as damaging to an individual's health as smoking a pack of cigarettes a day; yet increasing numbers of children and adults in the United States remain inactive. When individuals are asked what factors might persuade them to avoid sedentary behavior, become active, and take up fitness activities, the number 1 reason cited by respondents was that a recommendation from their physician would highly motivate them to make or consider this important lifestyle change.² Thus, physicians and other health providers have not only the ability but also the responsibility to both promote and prescribe exercise and activity. On many levels, tennis offers a great activity and sports option for those interested in becoming more active and, as a result, more healthy.²

The United States Professional Tennis Association (USPTA) has developed a nationwide initiative, *Tennis—For the Health of It!*^{SM3} and has partnered with the American College of Sports Medicine (ACSM) as part of their "exercise is medicine" endeavor. This health promotion effort will help spread the word about the health benefits of tennis, and it should also make it easier for physicians and health care professionals to prescribe and promote tennis to their patients.

Tennis: General Health Benefits

The benefits of regular exercise are well documented. In this article, we provide explanations why tennis is a great exercise activity and how it is one of the best choices for anyone who wants to be healthy and fit. Regular tennis provides individuals with general health benefits, such as improved cardiovascular and lung function, lower body fat, and decreased risks of diabetes and cardiovascular disease. It also gives one stronger bones supported by stronger and more flexible muscles, and improved balance, coordination, and proprioception. Although the physical benefits of exercise are widely publicized, the mental and emotional benefits have not been adequately promoted, yet they are just as important to a person's overall health.

Exercise has often been scientifically shown to relieve symptoms of stress, but it offers even greater benefits that have not been researched as extensively. Recently, it was discovered that a fast-paced workout such as tennis improves the production and release of brain-boosting proteins and increases the production of cells in the brain's hippocampus, which is where learning and memory function take place. For adults, an 8-year study found a relationship between physical inactivity and cognitive

See editorial for Dr. DiNubile's commentary on the benefits of tennis.

Correspondence:

Jack Groppe, PhD,
Human Performance Institute, Inc.,
9757 Lake Nona Road
Orlando, FL 32827.
Tel: 847-658-1077
E-mail: jgroppe@hpinstitute.com

decline across all subgroups.⁴ The sedentary lives of corporate workers result in insufficient physical stress, and that energy imbalance negatively impacts cognitive performance. The results also found a “dose” relationship between exercise and mental acuity—“a little exercise is good, but more is better” so long as adequate recovery is provided, and overtraining does not occur.

Tennis is the Ultimate Exercise Both Mentally and Physically

A typical tennis match can last from 30 minutes to several hours. Over the course of the match, a tennis player can run 3 to 5 miles. The average tennis point lasts 3 to 7 seconds, requiring rapid change in direction with sudden bursts of activity.⁵ In a typical tennis match, this involves 300 to 500 bursts of energy. Tennis both challenges and builds an individual's aerobic and anaerobic conditioning and also requires tremendous muscle strength and endurance.

Tennis-specific research has uncovered the following points:

- Because tennis easily meets the physiological requirements to be considered a moderate and even vigorous physical activity, individuals who participate in tennis 3 hours per week at the moderately vigorous intensity level can cut their risk of death from any cause in half.⁶ In the landmark study on physical activity and longevity, Paffenbarger et al⁶ specifically cite tennis as a moderately vigorous activity, along with swimming, squash, racquetball, handball, and jogging or running. Tennis match intensity has been documented using both heart rate recordings and maximum oxygen uptake (VO_2 max). Mean heart rate during singles tennis range from 141 to 182 beats per minute, which equates to 70% to 90% maximum heart rate. Mean oxygen consumption ranges from 50% to 80% of VO_2 max.⁷ Also, when one measures the energy expenditures involved in tennis using metabolic equivalent tests (METs), doubles tennis has been shown to fall into the moderate exercise category at 5 to 6 METs, depending on the activity code used. Singles tennis falls into the vigorous exercise category at 8 METs, which is similar in intensity to jogging at a pace of 5 mph or swimming at a moderate to hard level.⁸
- According to Finn et al,⁹ tennis players scored higher in vigor, optimism, and self-esteem and scored lower in depression, anger, confusion, anxiety, and tension compared with other athletes and non-athletes.

- Because tennis requires alertness and tactical thinking, it may generate new connections between nerves in the brain and promote a lifetime of continuing brain development.^{10,11}
- As a racquet sport, tennis outperforms golf and most other sports in developing positive personality characteristics (Table 1).¹²
- Competitive tennis burns more calories than many other sports and fitness activities, according to detailed charts comparing energy expenditures for a wide variety of activities.¹³ A detailed analysis compared various activities and the calories burned. The article showed that tennis ranks among the top 5 activities that one can participate in to burn the most calories, and it actually burns more calories than swimming, rowing, weightlifting, jazzercise, hiking, or golf.¹⁴ It is not surprising that tennis players tend to be more lean than the average person. Body fat levels are significantly lower in tennis players than in age-matched controls.^{15,16} They are also metabolically more fit, with improved lipid metabolism and lower incidence of hyperlipidemia.^{1,15} Obesity is a health hazard, with its incidence continuing to rise in children and adults. Tennis offers an excellent option for anyone wanting to shed unnecessary pounds and/or maintain a healthy body weight.

Physical Benefits of Tennis

Aerobic Fitness

Playing tennis burns fat, improves cardiovascular fitness, and helps the body maintain higher energy levels. More calories may be burned in high-intensity intervals of exercise interspersed with low-to-moderate intensity levels (Figure 1). Tennis, in its purest sense, is interval training because of the nature of how points are played. Because the heart rate goes into a so-called “fat-burning zone” and can easily go higher, tennis has been recognized as one of the leading activities to help burn fat. Also, because the intensity of tennis can get fairly high (depending on how hard a player works while playing), and because tennis is purely an interval sport, more fat is burned after working out than during the time on court. Thus, overall physical capacity improves both on and off the court.

As a testimony to this, Bloomfield et al¹⁷ determined that 7- to 12-year-old tennis players had superior cardiovascular endurance compared with casual sport participants. It has also

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Table 1. Tennis Outperforms Many Other Sports in Development of Personality Characteristics

	Tennis	Golf	Running	Weight-lifting	Inline Skating	Downhill Skiing
Sociability	Very high	Very high	Moderate	Moderate	Moderate	High
Spontaneity	Very high	Moderate	Low	Very low	Moderate	Very high
Competitiveness	Very high	Very high	High	Moderate	Low	Moderate
Risk-seeking	High	Moderate	Low	Low	Moderate	Very high
Focused	Very high	Moderately high	Very low	Low	Moderate	High
Aggressiveness	Very high	Low	Moderate	Very high	Low	Moderate

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been determined that singles tennis meets the intensity criteria established by the ACSM and the American Heart Association for developing and maintaining cardiorespiratory fitness.¹⁸ In another study of 141 tennis players 30 to 74 years old, Galanis et al¹⁹ observed that even moderate physical activity improved overall lung function.

It is well accepted that exercise-related oxygen use and capacity diminishes with advancing age, meaning heart-lung capacity also declines. However, Therminarius et al²⁰ found that playing tennis regularly appears to decrease the rate of age-related decline. Elderly players can also realize another benefit from tennis. When studying tennis players (≥ 55 years), Howley et al²¹ observed that older players had significantly improved their blood cholesterol profiles with higher high-density lipoprotein (HDL), which is good cholesterol, and a higher HDL to total cholesterol ratio than a control group. In reviewing 17 different studies, Pluim et al¹ found that singles play allowed a player to be in the 70% to 90% range of maximum heart rate, which makes tennis an outstanding activity for improving cardiorespiratory function.

Anaerobic Fitness

Playing tennis builds muscle power and improves physical capacity. Because the average point in tennis is over rapidly, with sudden bursts of activity, tennis allows players to fully engage their anaerobic (or power) system. During the short duration of a tennis point, the body relies on the energy provided by glycogen that is stored in the muscles. The natural repetition provided by tennis allows the body to adapt by building muscle and improving heart-lung function. Legros et al²² found that the rate of phosphocreatine concentrations (a measure of anaerobic capacity/fitness) recovery was much faster in tennis players or active subjects than in sedentary subjects.

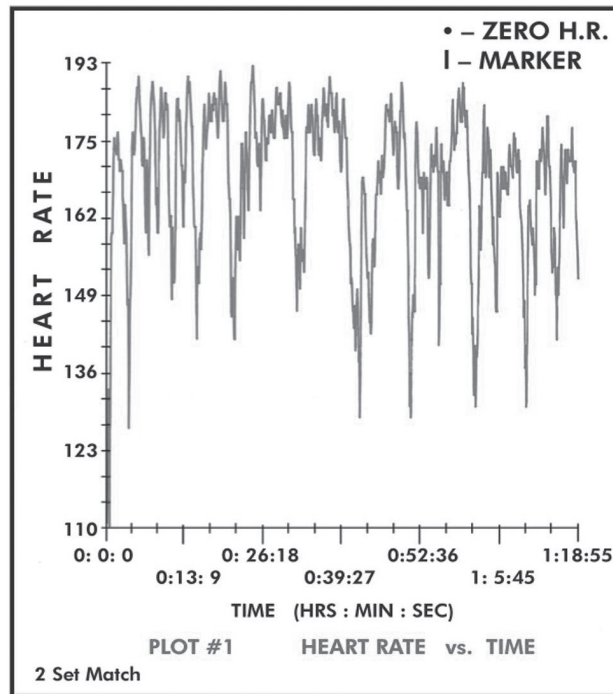
Improved Speed and Acceleration

Tennis improves a person's ability to accelerate. One of the key measures of athletic success is the ability to accelerate from a still position to maximum velocity. Regardless of the sports activity, accelerating and positioning are foundational to high achievement. In every point while playing tennis, one must explode, sprint, and recover for the next shot. This constant and repetitive "explosive movement" trains the body for forceful movements that truly expand one's capacity. As the muscles adapt to the need for improved strength and power, one becomes quicker and more agile.

In tennis, what matters is the first step, which requires anticipation, quick reaction time, and explosive action. Power is work divided by time or, equally, power is force multiplied by the distance moved and then divided by time. Because of the natural demands of tennis, improved power is a basic end result. Every move made toward the next shot is a very short distance (~4 m), so it should be questioned what kind of speed is required to play tennis. Although it does not require the speed for a 100-m dash, for instance, it does require a powerful first step, which enhances quickness in all activities. Because tennis players continually practice "ready, read, react, and explode" for each point, a powerful first step becomes a natural end product. This is why tennis is viewed as a terrific cross-training option for athletes in any sport. Athletes in a number of sports, including basketball, football, baseball, soccer, and volleyball use tennis as part of their off-season training regimen to help improve their fundamental skills. Dr. DiNubile has worked extensively with professional basketball players and knows several who feel that playing competitive tennis in high school and college significantly enhanced their basketball skills.

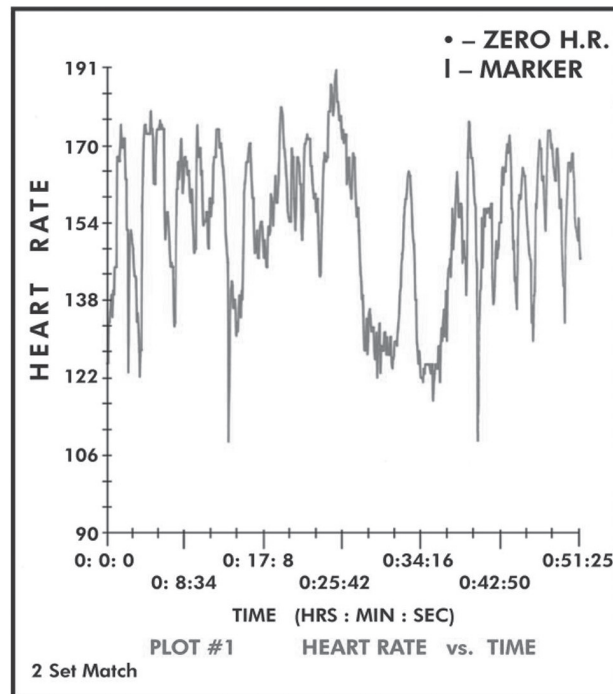
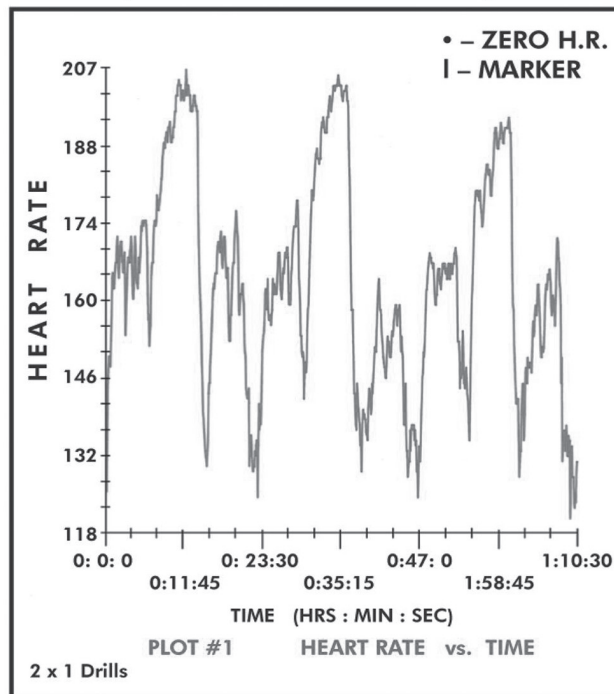
Speed is the distance one travels divided by time. Tennis is a sport that, through its very design, improves people's speed.

Figure 1. Heart rate of professional tennis players in a variety of tennis hitting workouts.



Left: Note the natural intervals that occurred in this match that took place over 1 hour, 19 minutes. It's obviously a great workout.

Below: If you compare the intensity of a workout between three players hitting two-on-one (bottom left), you can tell when this player is by herself hitting against the two other players. In another two-set match (bottom, right) over just 51 minutes, the workout is much better than you will find in other activities.



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During a point, players must respond to an opponent's shot, move forward and backward from the length of a 39-ft court (the distance from the baseline to the net) and side to side along the width of 27 ft (the distance in singles tennis from sideline to sideline), and sometimes even farther if they move diagonally. Based on the time per point and the distance a player must move during that time, tennis is one of the world's best activities for developing multidirectional speed.

Strength, Coordination, and Agility

Leg muscular strength can be improved through the hundreds of starts and stops that tennis requires. This includes both concentric and eccentric strength. The constant lunging, pushing off, or leaping to hit an overhead develops leg muscular development unlike many other activities. Laforest et al¹⁶ found that the muscles of tennis players demonstrated a greater resistance to fatigue than those of sedentary individuals across 2 sets of age groups (27–30 and 64–66 years).

Tennis develops incredible coordination and proprioception. It requires a finely tuned integration of the mind-body network. Not only must the tennis player be on the move constantly to get into position to return the opponent's shot, he or she must also be forward thinking to get back into position for the opponent's next shot. The player's ability to read the opponent's movements, predict the ball placement, position himself or herself at an optimal distance from the anticipated ball landing, prepare and execute his or her own return shot, then get back into position for the next shot is testimony to the mental and physical complexity of tennis.

In one investigation, timing was studied regarding how well a person tracks an object and positions himself relative to the arrival of the object. In a study examining tennis players and novices at ages 7, 10, 13, and 23 years, it was found that tennis practice accelerates the development of timing accuracy.²³ In a study specifically using tennis to examine aging and coordination, Lobjois et al²⁴ observed tennis players and non-tennis players of various ages (20–30; 60–70; and 70–80 years). A timing task had an object accelerating (at constant velocity or decelerating), and the subjects were asked to time their response to the object's movement. Even though all participants were affected by the velocity manipulation, this response bias was increasingly pronounced with advancing age in non-players, and no difference was found among player groups of different ages.

Tennis also enhances both gross and fine motor control. In tennis, movement and ball striking skills require control of large and small muscle groups. The large muscle groups get a great workout, not only from the force production but also from the coordination required to get into position. Andersson et al²⁵ observed tennis players reach higher flexion torques (rotational force production) than other athletes and non-athletes. Tennis players also demonstrated more strength in lateral movements. In tennis, the ball must often be slowed down and hit with a gentle, soft return. These shots are called *drop shots* or *drop volleys*. Hitting successful touch shots requires the development of fine motor control in the arms and hands to decelerate the racquet and hit a highly controlled shot that will barely clear the net with a very low bounce. In a study examining the ability to be rhythmically accurate and maintain a steady rhythm in movement execution (considered to be one of the best basic abilities of an athlete), Zachopoulou et al²⁶ found that a tennis group (compared with basketball, swimming, and a control group) was the most rhythmically accurate.

Tennis improves agility because it forces a change in direction as many as 5 times in 10 seconds during a typical point. The overall agility gained from playing tennis is tremendous. Also, coaches in other sports are constantly looking for ways in which to vary their practices and workouts. Cross-training has become a huge part of athlete's activities, both for the improvement and/or maintenance of all forms of fitness and the improvement of general skills that will benefit them in their specific activity. Tennis provides excellent cross-training for other sports that require rapid changes in direction, including football, basketball, soccer, baseball, and volleyball.

Dynamic balance (balance while moving) is as important in everyday life as it is in sports. Tennis requires total control of one's body even while running at top speed. This skill easily translates to everyday life. Tennis provides great dynamic balance training because it requires one to develop total body control to prepare for shot execution. Joint position sense and proprioception are also developed on the tennis court. Children benefit from learning tennis because it makes them more agile as they develop. Dynamic balance training is beneficial for older adults because it allows them to function at very high levels in normal life, even into their 90s. According to the American Academy of Orthopaedic Surgeons,²⁷ > 11 million senior citizens fall each year in the United States—that is 1 of every 3 people > 65 years, making it the leading cause

of injuries in the elderly population. Falls are also a leading cause of hospitalizations among persons of all ages; in 2000, falls accounted for 46% of all hospitalizations from injuries.²⁷ Prevention strategies to prevent falls are essential, particularly in those who have or are at risk for osteoporosis. The earlier that an individual incorporates preventive balance-type training, the more successful they will be in lowering their fall risk associated with aging.

Tennis players develop tremendous hand-eye coordination because they must constantly judge the timing between the oncoming ball and the proper contact point. This ability is developed both when stationary, and more often when moving at high speeds. Not only must the player position his or her body correctly to prepare for the shot, coordination is required to execute the swing. The trunk, arms, and legs must all work in sync with appropriate racquet placement coupled with impeccable timing to hit the oncoming tennis ball. If any of these are “off,” the player’s shot will suffer. In a study comparing 53 university athletes (including tennis players) and 46 non-athlete university students, Ishigaki and Miyao²⁸ determined that dynamic visual acuity of the athletes was superior to that of the non-athletes.

Flexibility

Because tennis players continually stretch and maneuver to return the ball to their opponent, they become more flexible. This includes both static and dynamic flexibility of major muscle groups of the upper and lower extremity and the core area. Tennis requires a player to get in position and “reach” to return the opponent’s shot. In one investigation, flexibility improved in children (average age 11.4 years) after a 12-week session of playing sports such as tennis. The average gain was 3.76 cm.²⁹

Cross-training

It is well accepted that athletes can improve their fitness and performance by embracing sports or activities outside their main sport. The eyes of the sporting world were opened to the cross-training benefits of tennis when it was revealed in popular literature during the mid-1980s that many world-class Alpine skiers played tennis in the off season. Tennis provides athletes of other sports with a wide variety of physical skills that translate back to their primary sport or activity. In a 1999 study, Japanese junior tennis players were compared with non-tennis-playing children, and it was determined that the

tennis players were superior in aerobic capacity, agility, and muscle power.³⁰ Tennis provides cross-training benefits on a variety of physical and mental parameters, perhaps more so than any other sport.

Additional Health Benefits

Bone Health

For years, scientists and physicians have recommended impact or weightbearing exercises for people who want to increase bone strength and density and prevent osteoporosis. According to Wolff’s law, bones remodel in response to mechanical demands placed on them. When used and “loaded,” more bone is laid down, and the “stressed” bone gets stronger.³¹ Tennis places bone-building dynamic stresses on the body, with a positive impact on skeletal health and overall durability. In general, the body adapts to bouts of mechanical overload by getting stronger. This adaptation is not only true of bones but is also seen in muscles, tendons, and ligaments.³¹ Optimal skeletal health necessitates movement and loading, and “if you don’t use it, you lose it.” As exercise physiologist Thomas Cureton once said, “the human body is the only machine that breaks down when not used.”

Experts usually recommend weight training, running, jogging, or even walking to build bones; however, when it comes to an activity that creates repetitive impact with the ground and impact when striking the ball, nothing beats tennis. Bone development for children is critical, and bone growth and maintenance for seniors is equally important. Pluim et al¹ analyzed 22 independent studies documenting the positive impact of tennis on bone health and bone density. Tennis players consistently had greater bone density in their dominant arm and better bone density in the hip and lumbar spine compared with age-matched controls. Interestingly, bone mineral content and bone density were greater in those who took up tennis at earlier ages. This underscores the importance of bone-building activities like tennis in children and teenagers, especially young females, who reach peak bone mass in their late 20s. The more bone that is “banked” early, the less vulnerable an individual will be, as expected skeletal losses occur in middle age and older. The key to a healthy adult skeleton begins in youth with proper exercise and nutrition. These are the critical bone-building years. Researchers also agree that tennis, 3 times per week, supports the exercise recommendations of the ACSM regarding physical activity and bone health, both for the development of bone minerals

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in children and adolescents and the preservation of bone health during adulthood.³² In the ACSM position statement on physical activity and bone health, the authors specifically cite tennis as a bone-building option.

Using tennis players as the experimental group and comparing them with sedentary people of the same age, Pirnay et al³³ clearly demonstrated that there was a positive correlation between the tennis players and bone mineralization. In another study on this topic, the bone mineral content of athletes (tennis players) was significantly greater than that of non-athletes, but did not differ among the sports. Therefore, tennis contributes to bone mineral density.³⁴ When one considers the bone-building potential of tennis with its ability to improve balance, coordination, and agility, tennis becomes an attractive preventive strategy for the commons falls and/or fracture problems encountered in adult and elderly populations. Again, starting early, before higher level of fall risk becomes a contraindication to tennis, is the key.

Improved Overall Health, Immune Function, and Body Composition

Tennis promotes overall health, fitness, and resistance to disease through its conditioning effects. Studies have demonstrated that the more active an individual is, the stronger and healthier his or her immune system will be. The intensity of exercise helps to strengthen the immune system further. Therefore, it makes sense that tennis, with its inherent demands for heart rate, interval training, impact and agility is one of the most beneficial activities in which one can participate. Schneider and Greenburg³⁵ cited tennis specifically as an activity in which participants were less likely to be obese, smoke, or be involved in other forms of threatening activities compared with those who participate in team sports and an aggregate of other sports. These positive lifestyle choices allow for optimal immune activity and function. We also know that systemic inflammation can have serious negative health implications, and inflammation can be related to excessive body fat. Laforest et al¹⁶ discovered that recreational tennis players who participate twice a week had a lower body fat percentage than age-matched control groups.

Finally, adding to the study conducted by Paffenbarger et al,⁶ Houston et al³⁶ published a longitudinal investigation of > 1000 male students examined after an average of 22 and 40 years. Sustained playing of activities such as tennis was associated with a lower risk of cardiovascular disease. They inferred

that a primary factor for this beneficial health profile may be that tennis was the sport played most often through middle age.

Psychological Reasons to Play Tennis: The Mind-Body Tennis Connection

Tennis offers tremendous mental and psychological benefits for individuals of all ages, from building confidence and self-esteem in children to reducing stress and maintaining cognitive abilities in adults and seniors. Studies have demonstrated that people who play tennis develop a perception of control in what they do. In one study of football players, tennis players, and non-athletes, the tennis players and football players had a greater perception of control than the non-athletes. Additionally, tennis players were found to be highest in personal efficacy, meaning that they felt they could achieve the desired results more effectively.³⁷

Tennis can help improve the habits surrounding self-discipline and decision-making abilities. In tennis singles, the player is alone on the court, making his or her own decisions, planning strategies, and developing innate skills of self-discipline. In 1996, Yoo³⁸ examined self-confidence and competition anxiety among players in various sports activities. Tennis was among the sports examined in which several psychological factors of players were studied. Yoo³⁸ found that the higher the sport orientation, the less competition anxiety and more self-confidence was reported. In another investigation of wheelchair tennis participants, Greenwood and Dzewaltowski³⁹ compared wheelchair tennis players with wheelchair non-tennis participants. It was determined that wheelchair-mobile people participating in tennis appear to be more confident about general wheelchair mobility tasks than wheelchair mobile nonparticipants.

Tennis builds responsibility and discipline. It requires the player to practice and show up for competition on time with all the necessary equipment. In a study examining performance attributions and how self-centered an individual was, Van Raalte⁴⁰ observed that people tend to take credit for success and blame external factors for failure. This investigation observed that in a laboratory setting, these self-serving biases were confirmed. However, when observing tennis players and their performances, the incidence of self-serving attributions was significantly lower.

Stress Management

The physical, mental, and emotional stress of tennis forces the player to increase his or her overall capacity for stress management. Stress is a normal part of living, and when managed effectively can actually be beneficial to the overall growth of an individual. However, when it is unchecked, particularly in long-term situations, it can take its toll on one's health.

The singles player is out there alone. Stress can be a powerful stimulus for personal growth. The key is to learn and develop effective coping and management skills. The key to successful living is learning techniques to build recovery naturally so that stressful situations are better managed and diffused.⁴¹ Tennis helps to build recovery in a natural way by the very essence of how it is played. The player gets to regularly practice thinking and acting under stress, which is huge preparation for life skills. It is a continual battle with an opponent and oneself. Every point has the capacity to become an emotional slap in the face. Yet the more one plays, the more effectively one learns to manage the stresses that life and tennis competition create.

Recovery—Not Just Physical

Because of the nature of tennis, a player must learn to recover quickly, adapting to the stress that each point presents. Fitness, both physical and mental, has always been measured by how quickly one can recover from a bout of stress. Everything about the human system oscillates. Brain activity, heart rhythms, and sleep cycles are just a few of the body's systems that constantly go up and down. There are also predictable biochemical and hormonal changes. By the very nature of how it is played, tennis virtually duplicates this natural oscillation. Stress or heart rate goes up during a point, and then recovery occurs for very short periods between points. The ability to recover from bouts of stress is a skill that can be modified and trained. Loehr⁴² has demonstrated how to use the between-point time in tennis to recover from the stress of the previous point and then prepare for the upcoming point.

Tennis professionals work with coaches to learn muscle relaxation, breathing control, focus, and improved concentration. They also learn to project confidence, even under duress, and not allow negative emotions to intrude into their recovery time. The certified tennis teaching professionals can teach the same skills to recreational players and even beginners.⁴³ An effective tennis coach or instructor can provide additional

benefits. In his doctoral dissertation research, Ryska⁴⁴ found that highly supported tennis players reported lower anxiety compared with less supported athletes. As predicted, a significant coach support state was seen in people who were able to reduce higher levels of inherent anxiety. Tennis coaching can and will help one with all of life's battles. The mind-body connection, as it relates to tennis, was also referenced in an article in which the question was asked: "how good are you at playing tennis?" The reason this was asked was because good coordination appears to be an important marker of how intelligent we are.⁴⁵

Life Lessons

Tennis particularly lends itself to the physical and emotional development of children and young adults. There are countless life lessons between the lines of a tennis court, and in the time before practice and/or competition. A tennis player quickly learns about victory and defeat. The legendary Chris Evert said it best: "if you can react the same way to winning and losing, that's a big accomplishment. That quality is important because it stays with you the rest of your life, and there's going to be a life after tennis that's a lot longer than your tennis life." In a study examining adolescent tennis players and a group of adolescents who did not participate in sports, Daino⁴⁶ found that tennis players scored higher in extraversion and a will to win, while exhibiting less neuroticism, anxiety, apprehension, obsession, and depression than non-sport participants.

Tennis builds self-esteem. In a study on achievement and self-esteem in female athletes in which tennis was one of the sports examined, Brown⁴⁷ determined that participating in a sport such as tennis is an avenue in which females can experience achievement and enhanced self-esteem. Tennis also teaches teamwork, fairness, honesty, respect, and overall sportsmanship. Great tennis players have learned to fight a one-on-one battle on the court, but they are also incredibly sportsmanlike when their opponent hits a great shot. All of the great players have been seen clapping their racquet face at a great shot or they have been heard saying, "great shot" or "well done." Any athlete, at any level and in any sport, can learn about the essence of sports and competition and how it should be by watching one of the many tremendous matches between Roger Federer and Rafael Nadal. The combination of talent and professionalism seen in these top players, and not uncommon in the world of tennis, would be a welcome addition to many other sports arenas and venues in our modern world.

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Tennis helps develop problem-solving skills. It is a game of rhythm and preparation. In between points, players prepare themselves physically, emotionally, and mentally for the next point. Performance rituals are often used before each serve or return to control rhythm and deal with pressure. These same preparatory skills can transfer to taking examinations, conducting a meeting, or making an important presentation.

In the mid-1980s, Loehr⁴² demonstrated how tennis players use pre-performance rituals as they prepare to serve or return serve. He taught that after every point, great tennis players have developed the skills for 4 very specific actions. There is a positive physical response after the point, a relaxation phase, mental preparation, and then rituals. When serving, for example, a person decides where to serve the ball, how hard to hit it, and with what kind of spin. This mental preparation ritual plays a huge role in many other sports activities as well as life. Research at the Human Performance Institute has shown that “great leaders know how to manage their energy.” Tennis can provide a perfect training ground in which one can learn to prepare for a wide variety of situations. Tennis is a moving chess match, working the brain and the body in a positive way.

Although competitive at its heart, tennis can also be great fun for its participants. People who play tennis on a regular basis experience healthy feelings of enjoyment, competitiveness, and physical challenge. It is a fun activity, and it is very social. Whether you play at a club or the public parks, tennis players always gather before and after matches. The gatherings that can be seen after league matches develop incredible camaraderie. The connections made through tennis play can and often do last a lifetime.

Additional Considerations

There is a growing body of scientific literature to support the promotion of tennis by physicians and health care professionals; however, more in-depth tennis-specific studies are needed if we are to better understand the full array of benefits gained by regular participation in tennis, as well as the limitations and potential risks. Marks⁴⁸ provides a thoughtful comprehensive review of this subject and excellent recommendations for future investigation.

As noted, tennis is not without its risks. Although it is considered a relatively safe sport, there will still be injuries. These include both acute injuries and the more common overuse type. Both Perkins and Davis⁴⁹ and Pluim et al⁵⁰ provide detailed analysis of the tennis-related injuries and

strategies for prevention. Injury rates can be minimized with attention to proper instruction, proper equipment, and overall balanced conditioning. Modification of program design and teaching are recommended for those with orthopedic and/or medical conditions, and this can easily be accomplished when necessary. In addition to traditional tennis instruction, there are many innovative, creative programs that allow for more rapid learning, fun, and fitness on the tennis court without the need to “play” traditional tennis. These programs are invaluable for children and inexperienced adults, or even adults who need modifications because of orthopedic or medical issues. As we deal with an aging population, especially those with musculoskeletal conditions, the need for exercise modification becomes essential.³¹ This is true not only on the tennis courts, but also any time adults take up activity and/or exercise. The ACSM has excellent recommendations for prescribing and promoting physical activity for older adults and these should be taken into consideration when prescribing any exercise program or sport for older individuals.⁵¹

Conclusion

Tennis is a lifetime sport with numerous health benefits³ for individuals of all ages. It is almost never too early or too late to start. Physicians and other health care professionals can play an important role in educating patients and the public about the tremendous health benefits of tennis, and motivating them to take up this wonderful activity as part of an overall exercise prescription.

The USPTA has developed an initiative, *Tennis—For the Health of It!*SM This nationwide effort helps spread the word about the health benefits of tennis, and it should also make it easier for physicians and health care professionals to learn more about tennis, and to prescribe and promote tennis to their patient population. In the opinion of the authors, it would be hard to find a better exercise choice for individuals wanting to become more active and to reap the numerous health benefits that exercise offers. In fact, we believe that tennis should be considered any time exercise and activity are being discussed, recommended and/or prescribed by physicians. There are a variety of programs offered by certified professionals for individuals of all ages and all skill levels to get interested participants off to the right start for lifetime of fun and improved health.

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Conflict of Interest Statement

Jack Groppel, PhD discloses conflicts of interest with Glaxo-SmithKline and Procter & Gamble. Nicholas DiNubile, MD discloses conflicts of interest with Genzyme Biosurgery and H-wave®.

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CLINICAL FEATURES

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