

# **Defensive Martial Arts Instruction for Elderly Subjects: A Prescription Against Neurodegenerative Disease?**

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## **Introduction**

The quality of health care available in the United States has improved dramatically over the past few decades, which has contributed to an increase in the relative size of the elderly population. As the size of this subgroup grows, so too do cases of age-related neurodegenerative diseases, as well as the costs and sociological problems associated with such maladies. Prescription drugs are being continually developed to target many neuronal disorders, but this treatment regimen is not always ideal; elderly patients often have a variety of prescription medications, increasing the potential of dangerous side effects. Furthermore many of these drugs are unaffordable to a large proportion of the people they might help. Thus, a continual thrust in clinical neurobiology is a push for lifestyle choices that will improve and/or maintain mental health. Healthy lifestyles are in many ways advantages over synthetic pharmaceuticals: there are no associated harmful side effects and, because lifestyle choices are holistic in their effects they prevent not only specific symptoms of particular

ailments but also promote overall wellness, improving the ability of patients to withstand many kinds of diseases.

Ironically, despite advances in the understanding of neurodegenerative diseases and the development of drugs to combat such maladies, the typical American lifestyle significantly contributes to the chances of an individual acquiring neural disorders. The main factors involved in this “lifestyle” (from the biological point of view) are diet, stress and activity level. Diets high in saturated fats and processed sugars (common in America) are associated with the inhibition of key neuronal proteins, preventing them from carrying out their normal functions, leading to the onset of neurodegenerative disorders.

The second lifestyle factor, stress, impairs the immune system and damages the nervous system by causing oxidation. Oxidation damages proteins and other biological molecules (including fatty acids).<sup>1</sup> Emotional stress also impedes the performance of the cardiovascular system by raising blood pressure and heart rate. This impairs the delivery of vital nutrients and oxygen to the brain, compounding the effects of oxidation alone. Finally, stress raises the levels of toxic products such as stomach acid in the bloodstream. These products may interact in a harmful manner with the nervous system.

The last major factor of lifestyle affecting mental health is a person's activity level. In a study performed at an assisted living center, Zee and colleagues found that a combination of physical activity and social interaction helped elderly subjects improve their performance on a test to assess their memory and also experienced deeper sleep than subjects who were

not part of these activities.<sup>1</sup> Part of the reason for their deeper sleep, the authors suggest, was the regular schedule at which they participated in activities.

Atop all these other problems are the detrimental effects that typical American lifestyles have on overall health. Because nervous system functionality is inseparable from that of the other systems of the body, the direct effects of poor diet, high stress and low activity on the nervous system are worsened indirectly via damage to the rest of the body.

Athletic activities offer positive benefits to the mental health of all people but are especially useful for elderly persons. This is because exercise activates several biochemical processes within the body. One of these processes is the secretion of hormones such as testosterone, which protects the brain against degradation. It also causes the cells near neurons to release compounds that stimulate neural activity. One of these compounds, called “dopamine,” is required for the brain to initiate movements of the body.

Besides lifestyle factors, there are many risk factors involved in neurodegenerative disorders that are inherited through ones parents (genetic factors). People who carry a defect in the DNA encoding for the “parkin” protein, for example, are predisposed to develop Parkinson’s disease at a relatively early age.<sup>2</sup> Genetic factors also affect a person’s cardiovascular health, which indirectly (as discussed above) affects neurological health.

Martial arts are athletic activities that afford individuals the opportunity to improve their stamina, flexibility, balance and strength. Furthermore, the research done by Zee’s group suggests that elderly people would benefit most from regularly scheduled,

structured exercise, as this would promote a regular “rhythm” in the daily lives of participants. Martial arts classes could provide this structure as well as the aforementioned benefits. Despite such promise, few elderly people in the U.S. participate in the martial arts, and many of those who do have been training their entire lives. The disparity between participation levels in elderly and younger Americans in the martial arts is due to many factors, one of which is the perception that elderly persons are weak and unable to safely participate in martial activities due to risk of injury. How important is this risk when weighed against potential benefits of participation in martial arts activities, specifically defensive martial arts?

If we are interested in the potential benefits of martial arts to neurological health in the elderly, we must understand on a biochemical level, some of the events that occur in neurodegenerative diseases and also how these events might be changed or ameliorated through martial arts training. As examples of neurodegenerative disorders, we will focus on Alzheimer’s disease and Parkinson’s disease, arguably the most prevalent neurological diseases in elderly Americans.

### **Biochemical Events in Neurodegenerative Disease Progression**

Many people assume that mental diseases in the elderly are the result of a system that can no longer operate, like a watch battery that runs out of energy. In reality, neurological disorders represent a very active and functional set of processes within the nervous system, which lead to failure that is

catastrophic on a very small scale. Over the course of these events, cells that have been damaged by environmental stress or genetic factors receive signals from nearby, healthy cells. These signals tell the damaged cells to initiate a process called apoptosis, the equivalent (to the cell) of suicide.<sup>3</sup> This process is ingrained into all systems of the body as a way of protecting against system-wide threats like cancer. The fact that neurodegeneration occurs via programmed death of cells in the neural system reveals not a tendency of the nervous system to fade away over time but a general inclination for the body to seek out and destroy malfunctioning parts. Preventative measures such as synthetic drugs and exercise regimen are important aspects of nervous system maintenance in light of this process, because they prevent extensive damage from occurring in individual cells. This in turn prevents apoptosis.

Throughout their lifetime, the cells that control our ability to receive stimuli and interact with the world around us, cells that comprise the nervous system) face a variety of survival-threatening events, including malnutrition and oxidation. Neural malnutrition occurs when the brain cannot get an adequate supply of its fuel, glucose, possibly due to inadequate blood circulation. The second process, oxidation, occurs throughout the body. Oxidation accelerates aging by chemically damaging molecules involved in maintenance. Within the nervous system, oxidation changes neuronal proteins that control events in the brain. This increases the risk of neurodegenerative disorders like Alzheimer's and Parkinson's disease.<sup>4</sup>

When a person has Alzheimer's or Parkinson's disease, the rate of oxidative change in important

neuronal proteins involved specific to each disease is very high. Alzheimer's disease is triggered by damage to a molecule called the amyloid- $\beta$  (AMB) peptide. Damage causes AMB to form plaques within the brain that disrupt the delivery of oxygen and key nutrients like glucose.<sup>5</sup> This can lead to further damage via neural malnutrition.

Parkinson's disease is caused by damage leading to the death of neurons responsible for maintaining dopamine levels in the brain. Dopamine is required for the initiation of movements. These neurons normally form an important part of the brain called the "motor cortex." Both diseases result in pain and a loss of motor control. Significantly, each disease is caused by abnormal biological behavior within a specific set of cells and *not* by simple wear and tear.

Another survival-threatening event experienced by neural cells is the accumulation of waste products. These materials may be the byproducts of normal metabolic functions of cells, or they can be molecules that underwent oxidative damage like the AMB peptide involved in Alzheimer's. Neurodegenerative disease progression is accelerated when there is a significant buildup of these products.

The survival of neurons in the face of diseases like Alzheimer's and Parkinson's depends on the ability of the body to provide the nervous system with the nutrients it needs and also on the ability of the nervous system to repair damage from processes like oxidation. This means that lifestyle factors discussed above can be an integral part of therapy for age related mental disorders. Activity can be especially beneficial by inducing regular sleep patterns and promoting general wellness.<sup>6</sup> These beneficial effects

of activity augment the body's ability to repair oxidative damage, provide energy to neural cells and dispose of waste products—all-important aspects in preventing neurodegenerative disease.

While there are a variety of activities available to the elderly, the defensive martial arts would be especially beneficial to subjects from this age group because certain aspects involved in martial arts training promote mental health and inhibit the development of neurodegenerative disease. While there are very real risks involved in martial arts participation, these can be mitigated under proper supervision as long as participants already have a basic level of fitness. Furthermore, martial arts present the opportunity for participants to continually develop and refine new motor skills. As discussed later, this process is beneficial in terms of protecting the nervous system from biochemical degradation. While developing these skills, martial arts students improve their overall conditioning, which is also very beneficial to the nervous system. It is these two hallmarks of the martial arts experience, skill development and refinement through repetition, and general conditioning that will be focused on here as effectors of biochemical pathways that protect the brain from degradation. These biochemical processes suggest that instruction and practice in self-defense martial arts could promote the maintenance of mental health in the elderly.

## **Hallmarks of the Martial Arts Experience: Skill Acquisition through Repetition and Conditioning**

The processes of physical exertion and technique perfection through repetition are very important parts of martial arts training. The concept of repetition should be familiar to anyone who has taught or taken a course in a martial art. When learning new techniques in martial arts classes, students are often told “you will need to do this 100 times to learn how to do it. Then you will have to do it 1000 more times to become good at it.” Martial artists of higher ranks take this mantra to further extremes, repeating techniques not thousands but tens of thousands of times in order to hone their skills.

For any participant, technique development is important not only because it provides direct neurological health benefits but also because it presents individuals with concrete, attainable goals. This tends to increase focus during training and encourage people to adhere to a training regimen. Motivation like this is important for elderly subjects who might be suffering from neurodegenerative diseases, as the onset of such conditions often exacerbates feelings of depression and helplessness.

Along with technique repetition, martial artists engage in a conditioning regimen. A well-conditioned person, after all, is better physically equipped to handle some of the symptoms of stress stemming from threatening situations, including elevated heart rate. Also, a well-conditioned subject can practice the same techniques for a longer period of time because his/her stamina is greater and the risk of injury from



performing the exercise decreases. Thus, complete defensive martial arts training involves some physical conditioning aspect.

These two characteristics of martial arts cause important changes in participants. Entire studies could be performed on attitudinal changes produced by this training, and how these factors might improve the mental health of elderly martial artists. However, here the focus is on the biochemical changes that occur within the nervous systems of martial arts participants when they perform the conditioning regimen and technique repetition associated with martial arts training. Like traditional (consumable) forms of medicine, martial arts training can prevent some of the more severe biochemical changes associated with neurological disease from occurring. This prevention occurs because exercise and skill acquisition involve the activation of biochemical pathways within the nervous system.

### **Biochemical Changes in the Nervous System due to Conditioning**

Our bodies constantly adjust factors like core temperature and heart rate in an attempt to maintain a balanced condition; this process is referred to as homeostasis. Homeostasis allows our bodies to adapt to various exercise regimens. When a person performs general conditioning exercises (those that are designed to improve flexibility, cardiovascular health and muscular strength) over long periods of time, the body prepares itself for this regime by making many chemical changes, among them: 1) elevating secretion of sex hormones into the bloodstream (estrogen in women, testosterone in men); 2) increasing the

amount of oxygen delivered to cells through the cardiovascular system; 3) depleting glycogen and fat stores to generate energy. While these changes are known to inhibit heart disease and cancer, they are also critical in slowing the onset of neural degeneration.

Recent research shows that there are direct neurological benefits from exercise. When mice perform exercise in the form of running on a treadmill their brains are protected against toxins that normally destroy the movement initiating compound dopamine.<sup>7</sup> According to Suttoo *et al*, this most likely occurs during exercise because the level of calcium in the blood increases. Some of this calcium is extracted from the blood within the brain and used to activate an enzyme that is involved in synthesis of dopamine.<sup>8</sup> This method of initiating dopamine release could be very useful in Parkinson's patients. Currently, it is common medical practice to orally administer L-DOPA, a precursor of dopamine, to Parkinson's patients<sup>9</sup> since dopamine is incapable of crossing the blood-brain barrier, whereas L-DOPA is.

When L-DOPA is administered orally, however, this compound generates dopamine that targets not only the motor cortex but also centers in the brain that control mood. When targeted to these mood controlling centers, dopamine can cause psychiatric episodes.<sup>10</sup> Since dopamine generated via calcium in the blood is not targeted to mood control centers, the maintenance of dopamine levels through exercise is a safer and cheaper alternative to administering L-DOPA.

Besides elevating calcium levels and other beneficial compounds within the blood stream,

exercise also promotes maintenance of the sex hormones testosterone and estrogen. Researchers at the University of New Brunswick in Canada have found that a single bout of exercise can increase the blood levels of hormones in women, including elderly subjects.<sup>11</sup> In male subjects, Fiet *et al* have documented a strong correlation between fat loss and blood-serum testosterone levels, and a weaker direct correlation between exercise and testosterone levels.<sup>12</sup> Thus, through direct and indirect means, exercise promotes the maintenance of sex hormones in the bloodstream. These changes are especially important in light of the normal aging process, in which blood levels of sex hormones decrease rapidly as people pass middle age.

While they are ubiquitously beneficial to overall health, these sex hormones have been shown also to specifically act against neurodegeneration. Using an artificial (*in vitro*) system of cultured human cells, several groups have shown that both estrogen<sup>13</sup> and testosterone<sup>14</sup> prevent damage to the brain caused by oxidation and other processes. Oxidative damage is mitigated because both hormones reduce the levels of AMB peptide, the molecule which, when oxidized, yields plaques that accelerate the symptoms of Alzheimer's disease. These studies provide validation that physical conditioning directly inhibits the progression and onset of neurodegenerative disease.

By increasing the availability of testosterone and/or other sex hormones in elderly subjects, exercise provides neural protection by improving the ability of the body to prevent oxidation from damaging neuronal proteins. Further studies performed with mice have shown that exercise can increase the levels

within the brain and bloodstream of proteins that protect against neural degradation (these proteins include synapsin I and CREB).<sup>15</sup> This is very promising because these proteins are normally lost because of lifestyle factors like diet and stress level. Furthermore, direct replacement of these proteins via infusion orally or intravenously carries the chance that the protein may not be delivered in sufficient quantity to ameliorate neurodegenerative conditions, and also the risk that the proteins used for treatment will activate unintended biological pathways (which may be dangerous for the patient).

Exercise also plays an indirect role in maintaining neural health. This is because physical conditioning strengthens the cardiovascular system, allowing the heart to deliver oxygen and nutrients to cells much more efficiently. This alleviates the potential problem of malnutrition in the brain and accelerates the rate at which waste products are discarded; both processes reduce the likelihood of oxidative neuronal damage. Thus, a person with a healthy cardiovascular system has a greater chance of also possessing a healthy neural system.

Besides increasing the flow of nutrients and oxygen to the brain and increasing the presence of molecules like testosterone and dopamine that protect against nervous system degradation, exercise carried out in a group setting offers emotional benefits through social contact and self-esteem building. This is important biochemically because both of these processes are means of combating depression-induced stress. This is particularly important in patients suffering from neurodegenerative diseases, whose loss of functionality is usually accompanied by a high degree

of anxiety and frustration. Thus, exercise can have neuroprotective benefits as an inhibitor of depression and anxiety, thereby offering some protection against stress-induced neurodegeneration. A study done at the University of Arizona indicated not only improvements in motor skills practiced during student-led training sessions but also a decline in loss of cognitive function in Alzheimer's patients participating in supervised exercise programs involving some cognitive stimulatory activity.<sup>16</sup>

Having explored some of the important biochemical benefits to the neural system that occur during exercise, the argument for martial arts as an effective neurological health measure in the elderly will now turn to the other hallmark aspect of martial arts mentioned above, technique development. While general conditioning produces effects that are holistically beneficial to the entire body, technique repetition produces benefits that are almost exclusive to the nervous system. "Use it or lose it" is a very relevant proverb when it comes to the human brain, which can undergo atrophy if not provided with a sufficient degree of stimulus. Through technique development, martial arts can provide that stimulus. The biochemical phenomenon that links technique development to mental health is referred to amongst researchers as "neuroplasticity."

### **Biochemical Basis for Learning: Neuroplasticity**

The notion of repetition as a requirement for mastery is, of course, not unique to martial arts. All athletes use drills to prepare themselves for sporting

competitions, repeating many times over in practices what might only be done a few times in games. NFL Hall of Fame member Don Hutson is famous for saying “For every pass I caught in a game, I caught a thousand in practice.” Outside of athletic endeavors, everyone from students to businessmen utilize repetition to memorize facts and learn skills. The refinement of techniques ranging from flying kicks to wrist locks through repetition, like language acquisition, causes chemical changes in the brain of the student. This process is commonly referred to as the development of “muscle memory” amongst athletes.

A dogma in modern neurobiology is that learning is accomplished via biochemical changes, including synapse formation, in the brain. This widely accepted view requires a nervous system that is not static, but rather a plastic system that can change and adapt to the needs of the entire organism. Observations of this malleability of the nervous system, termed “neural plasticity,” are very prevalent in neurobiological literature, and include increased synaptic development in the regions of the brain controlling hand movement within string instrument players. The region of the brain controlling movements, which is remodeled during martial arts training, is located near the cerebellum and is called the “motor cortex.”

### **Neuroplasticity within the Motor Cortex**

Voluntary movements of skeletal muscles are accomplished via motor units, which consist of a single  $\alpha$  motoneuron and the muscle fibers it innervates. Complex movements (including walking),

coordinated via the excitation and inhibition of many individual motor units, are controlled within a region of the motor cortex known as M1. This coordination is brought about by development of synapses within M1 in response to repetitive training. Greater numbers of synapses increase the available response to stimuli. Increased synaptic connection, because each synapse can be excitatory or inhibitory, allows fine-tuning of voluntary movements. In one of many experiments supporting the neurobiochemical basis of learning, Karni *et al* showed that when human subjects practiced sequences of finger movements over several weeks, the relative area of M1 recruited in the activation of these movements (according to blood oxygen levels recorded by MRI) was larger than the area recruited to execute an unpracticed sequence.<sup>17</sup>

As Karni's study suggests, in order to learn to perform new movements, from walking to spin-heel kicks, we have to perform these movements enough for our brains to change. This allows us to perform the movement as a coordinated motion initiated by a motor cortex program, rather than the sum of several smaller motions controlled by less action-specific programs. The increased level of synaptic connectivity developed around one activity allows us to perform this task without as much thought as it initially required. If the movements were practiced thousands of times, they might even become automatic, (a goal for most martial artists, who train to perfect techniques). As one might expect, martial artists develop strong innervation within M1 related to the movements they most commonly practice. Such a high level of innervation is uncommon amongst non-athletes. As proof of increased innervation and of

changes in the neural network due to training in martial arts, Mikheev *et al* report that Judoka who have gone through extensive training (relative to control subjects with little sports training) are more proficient with their non-dominant hand when performing simple manual tasks like holding a hairbrush or throwing a ball.<sup>18</sup> This is quite remarkable, considering that the tasks analyzed within the study did not involve Judo. A shift in preference of this sort demonstrates remodeling of the motor cortex to the extent that tasks for which no specific neuronal program was developed (i.e. left-handed ball throwing) could be performed with relative ease.

Because it involves technique development, martial arts can induce neural protection the same way as other activities involving skill acquisition, such as chess. This promotes the phenomenon of neural plasticity, enabling the brain to repair damage and/or to recruit new areas to be used in performing tasks when damage to other areas cannot be healed or avoided. One significant way in which technique acquisition in martial arts improves neural plasticity, shown by Mikheev and colleagues, is the recruitment of the non-dominant brain hemisphere to perform tasks, including those that are not related to martial arts.

### **Benefits of Martial Arts Relative to other forms of Physical Activity**

If exercise alone can mollify, perhaps prevent, some of the symptoms of degenerative neural diseases, why would martial arts be a particularly good regimen for



promoting mental health? This question is important to potential elderly participants because of the drawbacks to their participation in martial arts, paramount amongst them being the risk of skeletal injury, especially true in combative martial arts like Hankido. The risks of these injuries are very real, but must be evaluated as factors involved in the decision whether or not to pursue martial arts and not a definitive reason not to participate in them. While the risk of falling in martial arts certainly is higher than in many other forms of exercise, the actual techniques one chooses to practice can be tailored to minimize this risk. We would then assume that most elderly persons would refrain from the more dangerous aspects of martial arts (i.e. sparring, taking falls). More importantly, given adequate levels of bone strength, mobility and cardiovascular health and with the consent of a physician, elderly persons are often able to participate in activities that are traditionally reserved for younger participants.

One important case of elderly subjects participating in contact martial arts involved a sample population of members of a senior center invited to participate in Taekwondo classes for no charge.<sup>19</sup> In this study, all of the participants (who ranged between 63 and 81 years) who attended at least 85% of the classes (the study lacked a control group or a group who went to less than 85% of the classes because the group who went to more than 85% of the classes was the only group that chose to continue the study), experienced increases in strength, flexibility and balance as quantified by ability to do pushups, trunk flexions and to stand on one foot for a given period of time, respectively. This study demonstrates that, given

responsible instructors who demonstrate adequate concern for safety, elderly people can participate in high impact martial arts with relatively low risk of injury. Another critical component of this successful program was the consultation of both the director of the program and the program participants with a physician.

Even if they do not participate in high impact martial arts, elderly persons have the option of selecting other martial activities like tai chi, which involve slow movements and little if any contact. Tai chi has been studied extensively as a means of exercise in patients with cardiovascular conditions. In an article recommending tai chi to patients, *Nursing* magazine editors emphasize, “tai chi combines physical movement, meditation, and breathing to induce relaxation and tranquility of mind and to improve balance...strength and flexibility.”<sup>20</sup> Despite these benefits of low impact martial arts like tai chi, defensive martial arts such as Hankido would give subjects the added benefits, neurological and otherwise, of cardiovascular endurance in patients without debilitating cardiac conditions.

More significant than the fact that elderly people, with proper precautions, can participate safely in martial arts is the fact that martial arts involve complex movements that must be incorporated into muscle memory within the motor cortex. As discussed above, this practice has far-reaching benefits for the nervous system, suggesting that exercises involving complex movements, like Hankido and other defensive martial arts, would be more beneficial to the mental health of elderly persons and other participants than exercises like swimming that involve

simpler actions.

This assumption has been proven by animal studies. In mice with artificially induced lesions, Jones *et al*, showed that the development of motor skills is more beneficial than exercise alone in enhancing neural plasticity—the ability of the brain to remodel itself.<sup>21</sup> As the mice in the study practiced a complex set of acrobatic maneuvers, the number of synapses per neuron within the II/III layer of the motor cortex of the non-injured brain hemisphere (observed via histology) for mice with introduced lesions increased almost 125% relative to mice that underwent the same operation but whose exercise regime consisted of simple maneuvers. While it is expected that learning a new skill should increase synaptic development within the intact motor cortex, these researchers discovered that the acrobatic training significantly increased the plasticity within the lesioned hemisphere. Such a result is very promising clinically because it offers some chance of functional recovery in adults who experience brain damage.

Jones' findings are in agreement with Mikheev's in that they indicate neuronal plasticity is induced when motor skills are developed, and that the development of those skills can lead to altered functioning—in the Mikheev study, this was in the form of hand use preferences. Because some brain damage due to aging is likely unavoidable, the ability to recruit new sites for synapses, whether they control movement or other actions (such as speech) could be very beneficial in elderly subjects.

If martial arts can induce neural plasticity, participation in them may be beneficial for daily decision-making. This assertion is supported by

clinical research done by Cabeza *et al*, who used Positron Emission Tomography (PET) to record the spatial location of neural activity in elderly and young subjects completing a cognitive task.<sup>22</sup> Cabeza and his colleagues found that elderly subjects with low cognitive scores used the same regions of their brains as higher scoring younger subjects, but that elderly subjects could not use these same regions as efficiently because of degradation induced damage. However, the elderly subjects who had high cognitive scores utilized different cortical regions in the brain than either their younger counterparts and peers, suggesting that neural plasticity allows rewiring of synapses to compensate for damage, and that any activity that might contribute to that plasticity could preserve the abilities to make decisions and comprehend information.<sup>23</sup>

Since defensive martial arts involve both motor skill acquisition and physical conditioning, they can provide neuroprotective benefits both through endocrinological and direct neural pathways. Additionally, the common perception that elderly people cannot participate in such activities should not stop such men and women from benefiting from martial arts training. An important advantage of defensive martial arts over other athletic forms in terms of the ability of elderly subjects to participate is the lack of rules in such endeavors. Whereas sports, including Judo and Taekwondo, involve a fixed set of rules, defensive martial arts such as Hankido, like real life, involve no rules. Thus, a participant with a bad shoulder could avoid being thrown; a person with a bad knee could avoid high-impact kicking exercises. Individuals may adapt their techniques to their own

strengths and limitations. Because of this emphasis on adaptability of technique, conditioning and skill development through repetition, defensive martial arts, under qualified guidance, are an ideal activity for fighting neurodegenerative disease in elderly patients.

## **Conclusion**

As the elderly population in the United States continues to grow, the burden of age related neurodegenerative disease becomes an increasingly important public health issue. While there will always be a place in clinical neurobiology for pharmaceutical regimens, the costs of medication as well as the associated side effects dictate that they alone cannot answer the problems posed by these diseases. Additionally, the most desirable medical regimen for any disease must provide for the comfort, mental and emotional well-being of the patient in addition to his or her physical health. These circumstances implicate medical strategies involving holistic approaches to health, including participation in organized activities and a diet low in saturated fats and refined sugars, as very desirable parts of the overall health care strategy in these individuals.

Environmental and lifestyle factors play a critical role in the development of these diseases. These same factors influence the severity of the symptoms brought on by such diseases and may be useful in preventing them or delaying their onset. Because these factors can have a significant positive effect on patients' mood and general outlook on life, they have been highly touted by neurologists as important components in mental health maintenance and as

possible companions of synthetic and/or herbal drug treatments. Martial art training is a lifestyle factor that could have significant effects within elderly subjects in prevention of neurodegeneration. 'Soft' martial arts like tai chi have already been implicating as providing neurological and other health benefits to the elderly, but self-defense martial arts such as Hankido are rarely mentioned as beneficial activities for the neurological health of elderly patients. This is most likely due to the assumption that elderly persons will be hurt during such activities and that other forms of exercise could provide similar mental health benefits. However, with proper support from supervising staff, and instructors, along with regular consultation with a physician, elderly persons can mitigate their chances of injury in self-defense martial arts. Furthermore, by participating in these martial arts, elderly subjects have the opportunity to learn new skills, improving innervation within the motor cortex and also in regions of the brain involved in fulfilling cognitive tasks. According to a plethora of experimental evidence, the combined effects of improvement of brain remodeling ability and neural health benefits stemming from exercise make defensive martial arts a very promising means of therapy for preventing and/or mitigating the symptoms of neurodegenerative diseases like Alzheimer's and Parkinson's disease.

On a final note, participation in martial arts developed for self-defense can instill a sense of confidence in participants. While the actual ability of any student to translate martial arts techniques from the classroom setting to a threatening situation is quite limited, participation in self-defense classes can be empowering, while the process of technique

acquisition gives participants real, attainable goals to work towards in their martial arts studies. These are extremely important factors considering that anxiety and depression often accompany changes involved in the lives of elderly persons, including a loss of independence and feelings of loneliness. Anxiety and depression not only cause neurological damage, but also tend to exacerbate any preexisting mental conditions. Thus, even if self-defensive martial arts cannot ensure absolute safety for elderly persons (or anyone), they are a valuable activity, which offer participants the ability to improve their general health and increase their chances of avoiding neurodegenerative disease.

Modern technology has done much to change our opinions about the capabilities of mankind, but American societal preoccupation with youth tends to diminish our expectations of the capabilities of elderly people. Undeniably, any exercise or activity program undertaken by elderly persons involves risk, and any plan involving martial arts or other sorts of neurologically beneficial activities must be undertaken under the guidance of a clinician. However, the potential mental health benefits of training in defensive martial arts for elderly subjects demand that we approach this kind of activity not from the vantage point of why elderly people are incapable (because of fear of injury) of participating in martial arts training but rather by asking what sort of defensive martial arts training might be appropriate for elderly persons and how they stand to benefit from that training.

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- <sup>1</sup> Naylor.
- <sup>2</sup> Khan.
- <sup>3</sup> Mattson.
- <sup>4</sup> *Ibidem.*
- <sup>5</sup> *Ibidem.*
- <sup>6</sup> Naylor.
- <sup>7</sup> Tillerson.
- <sup>8</sup> Sutoo.
- <sup>9</sup> Nicholls, p. 286.
- <sup>10</sup> Mattson.
- <sup>11</sup> Copeland.
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