

Active Aging: Roles of Physical Activity and Immunity

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Received April 23, 2018 / Revised May 21, 2018 / Accepted May 24, 2018

We introduced the physiological responses of aging, active aging and also suggest the impact of physical exercise on body health status and elderly immunity. In this purpose, we searched the Pub Med data base for the articles (include our experimental papers) and review papers having the terms 'Aging', 'Active aging' and 'Physical activity and elderly' in the title, published from 1999 until 2018. The results were as follows: Exercise training has been extensively studied about the reduction of inflammation, oxidative stress, disease, and aging in syndrome X patients and elderly. Combined and aerobic or resistance exercise training could reduce obesity, insulin resistance, type 2 diabetes and hypertension. Exercise training has been extensively studied in cancer settings as part of prevention or treatment strategies. From this research, regular exercise has the potential to target tumor growth through regulation of inflammation and immune responses such as lactate clearance, NK cell activation (innate immunity), activation of cytotoxic immune cells, T cell activation (adaptive immunity), and immune surveillance. However, Endurance physical activity not only induces thermogenesis and diverse sports injuries but also elicits mobilization and functional enhancement of monocytes, neutrophils (which is caused by the cytokine changes such as TNF-alpha, IL-1) whereas it suppresses cell mediated immunity causing to increased susceptibility to inflammation and infections like cough and URTIs (upper respiratory track infections) in young and especially in elderly people. Therefore, Strategies to prevent physical fatigue, sports injuries include avoid overtraining, Adequate recovery and various type of rest during and after physical activity and assuring adequate nutrition supplementation such as glutamine, vitamin B, vitamin C, carbohydrate, ion or berry-contain sports beverages is helpful in physically active elderly.

Key words : Active aging, cognitive status, immunological changes, physical activity, quality of life

Introduction

It was reported that by 2050, almost the American 85 years old and over population will be triple. Korean elderly people will also increase in the same manner.

Physiological and mental losses are a part of normal aging as is decline in immunity. type 2 diabetes mellitus, hypertension, osteoporosis, osteoarthritis, cardiovascular disease, and cognitive function loss are common chronic conditions at age 85 [16]. Caregiver support, assistive technologies, and home based exercise programs are positively encouraged.

There are several papers described the relationship be-

tween immunological changes, including inflammation and immunosenescence, and age-related diseases such as depression, sarcopenia, sarcopenic obesity, neurodegenerative disorders [29].

And also, physical inactivity could be considered to be activating in life-threatening situations.

Physical inactivity (sedentary life style) and such life styles play an independent role as a direct cause cardiovascular and muscle function loss, shortening of health span, and decreases of basal metabolic rates, muscle metabolism, quality of life, brain function and immune responses [5].

There is generally understood by physically active people that regular moderate activity enhance immune functions, which appears 'immunosenescence' in the aging.

Physical activity causing an increase in the counts of circulating lymphocytes and functional activity. An increase in mitogen-stimulated lymphocyte proliferation include T cell proliferation and T cell production of diverse cytokines as

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well as B cell proliferations [11].

Moreover, physical training suppress and adapt inflammation and immune perturbations after heavy stressful exertion. This is well revealed by the intensified and repeated bout of heavy exertions.

However, prolonged and much strenuous exercises are often associated with immune dysfunctions, URTI (upper respiratory track infection) and sometimes overtraining syndrome.

Many elements of the immune system changes after prolonged heavy activity. During this 'open window', viruses and bacteria may gain a foothold, increasing the risk of clinical symptoms. It can be reduced the frequency of infection by the supplementation of carbohydrate beverages, glutamine, berry contained beverages, ion contained drinks in the recovery session after strenuous exercise [23].

This study revealed that carbohydrate supplementation has been related with higher blood glucose level, an diminished glucocorticoid responses, and reduced inflammation and fewer disturbances in lymphocytes counts, lower monocyte and granulocyte phagocytosis.

Sometimes, Cryotherapy can be used to recover the inflammation, homeostasis and immune responses. Cooling interventions such as cold water immersion, neck cooling cloth, mixed-menthols, and ice slurry appear to be effective method to reduce thermal strain and heat stress prior to, during and after endurance sport participations.

And it also can be utilized to improve exercise performance, sports injury rehabilitation [7].

In recent years, cognitive gerontology can offer tools to estimate the effects of interventions. It can offer exact measurement of memory, cognitive related functions and other aspects of perceptions [13]. That's why cognitive gerontology can serve setting standards for active aging.

For the elderly people, sensory changes, physical weakness, cognitive loss, falls and lung and cardiovascular diseases are prevalent and also difficulties with activities of daily living are common. It is the reason that elderly people must do regular exercise to sustain healthy aging.

However, few researches have researched the impacts of regular exercise on physical fitness, mental health, cognitive status, immunological changes and quality of life in the elderly.

Therefore, we introduce the physiological responses of aging first. and next, the analysis of physical activity on health status and immunity are presented.

Effects of physical activity on aging and active aging

It is well documented that organized and adequate physical exercise produces a favorable effect on the fitness and health of the elderly regardless of age. Moreover, for the elderly, pilates-based fitness program improves health-related QOL (quality of life) and mental wellbeing [28].

Because of dropout was high in high-intensity exercise especially in the elderly [6]. Even for the Taiwanese taekwondo athletes, there was accumulative effects of endurance activity and rapid weight loss deduced mucosal immune responses [27]. This implies that exercise intensity is most important factor for modulate health related parameters in physical activity participants.

For the elderly people, sensory changes, physical weakness, cognitive loss, falls and lung and cardiovascular diseases are prevalent and also difficulties with activities of daily living are common. This is the reason that elderly people must do regular exercise to sustain healthy aging.

In addition, caregiver assist, assistive devices, home service, transportation help, and home exercise programs are recommended.

However, few researches investigated the impacts of diverse physical exercise on health related parameters in active aging and healthy aging. And moreover, researches on the treatment for ill patients and disabled are inadequately reported.

Cognitive modifying therapy propose enhanced physical fitness, mental function and QOL. Graded exercise programs reduced fatigue and depression. which is induced by the enhanced physical activity and changed hormonal responses.

The other study also revealed various leisure activity and long-time exercise activity reduce older adults' risk of hav-

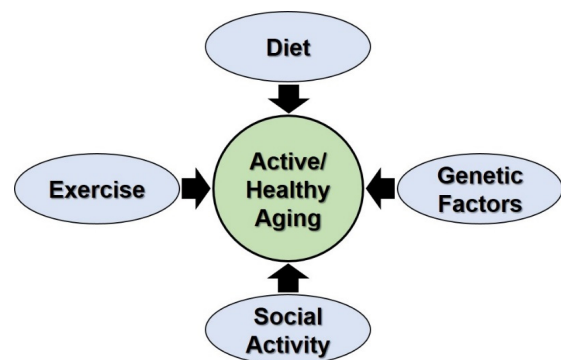


Fig. 1. The effects of exercise, diet, and genetic factors on active/healthy aging.

ing low-spiritedness. And also, this study show that elderly low-spiritedness is positively correlated with chronic disease [19]. Therefore, we might encourage older adults' join in diverse leisure activity to diminish psychological stress and depression.

Exercise training has been extensively studied about the reduction of inflammation, oxidative stress, disease, aging even depression in syndrome X patients and elderly. Combined and aerobic or resistance exercise training could reduce obesity, insulin resistance and hypertension [3].

This was also revealed in elderly woman, regular multi-component exercise programs increase bone connected QOL among women over 65 years with osteoporosis [24].

Exercise training has been extensively studied in cancer settings as part of prevention and treatment strategies. From this research, regular exercise has the potential to target tumor growth through regulation of inflammation and immune responses such as lactate clearance, NK cell activation (innate immunity), activation of cytotoxic immune cells, T cell activation (adaptive immunity), and immune surveillance [15].

Physical activity is known to improve muscle function, metabolic syndromes and, reduced risk for heart disease as well as cardiovascular system, as well as, cell mediated immunity, antibody mediated immunity

As mentioned above, Exercise also impacts on the cardiovascular system, which is modulated by increased level of sympathetic and parasympathetic activity. And therefore, beneficial effects on heart rate variability and prevent cardiac autonomic neuropathy.

It is known that the participation in regular exercise and physical activity has effects to prevent cardiovascular diseases in aged people. Exercise for the elderly should be divided by the purpose, activity type, exercise intensity, exercise time and duration [10]. Enhanced physical fitness by the exercise training on both men and women is noted to decrease

the relative risk factors of all-cause mortality including atherosclerosis, hypertension, diabetes, and cardiovascular disease from 20 to 50% [20, 22]. Low to moderate level of aerobic exercise has the potential to slow down aging-related functional deterioration by the restoration of nitric oxide (NO) bioavailability and the prevention of reactive oxygen species (ROS) generation in vascular endothelial cells [26]. In the elderly, the capacity of NO production in response to the exercise stimulus is dramatically decreased in vascular endothelial cells compared to young adults [18]. However, this difference between aged and young subjects is diminished by the regular exercise training. Blood flow is significantly higher in trained elderly people compared to sedentary elderly due to the increased capacity of NO production. These results support that the level of flow-mediated dilation in the trained elderly is higher than the sedentary [9, 18]. Prolonged high-intensity exercise is known to stimulate ROS production. However, the ROS production by exercise evokes resistance to the oxidative stress by increasing antioxidants. Thus, the enhanced antioxidant activity and diminished lipid peroxidation are observed in the physically active elderly [17].

For the young healthy individuals, even intense and endurance exercise training can inveterately induce transcriptional level transition in the peripheral blood leukocytes, up-regulate mitochondrial energetics and immune responses [4]. In this case, nutrition supplements such carbohydrate, ion-contained and polyphenols is most important factors and sleep or recovery is also important to prevent URTIs or open window.

However, it has been reported that endurance exercise not only induces thermogenesis and diverse sports injuries but also elicits mobilization and functional enhancement of monocytes, neutrophils (which is caused by the cytokine changes such as TNF-alpha, IL-1) whereas it suppresses cell mediated immunity causing to enhanced sensitivity to inflammation

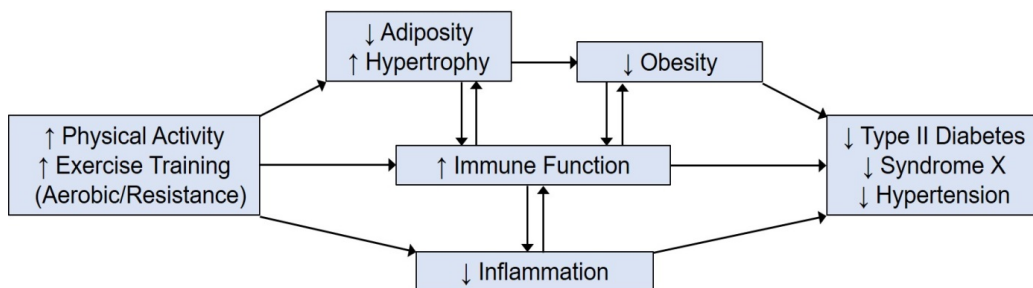


Fig. 2. General understandings of physical activity and immunity in aging.

and contagions such as cough and URTIs (upper respiratory track infections) [25]. Which is connected mechanisms with the open window, exercise-induced asthma, exercise-induced anaphylaxis, FDEIA (food-dependent exercise-induced allergy anaphylaxis) and overtraining syndromes. Overtraining syndrome is a neuroendocrine impairment distinguished by decreases in urinary norepinephrine output, maximal heart rate, decreased exercise performance, and self-awareness of high fatigue rate and stress too. This mechanisms have been likely to involved with autonomic dysfunctions [21].

Though the exact physiological and immunological mechanisms are not clearly revealed, Both cytokine kinetics and proinflammatory cytokine kinetics might explain reduced cell-mediated immune responses and enhanced allergy responses derived from type 1 to type 2 cytokine reactions (isotype switching occurs in antibodies), caused by mobilization of mast cells, neutrophils and monocytes [25]. And then this is also influenced by mental stress, which induced by competitive anxiety and other stresses.

Sometimes, Cryotherapy can be used to recover the inflammation, homeostasis and immune responses. Cooling interventions such as cold water immersion, neck cooling cloth, mixed-menthols, and ice slurry appear to be effective method to reduce thermal strain and heat stress prior to, during and after exercise.

Exercise-induced increases in core body temperature can negatively affect exercise performance and also can negatively affect immune response and inflammatory response [30]. It's known that the use of cooling interventions prior to, during or after exercise may enhance exercise performance [8, 12] and may reduce the exercise-induced inflammatory response [2]. The lower inflammatory response after post-cooling can be defined as an growth in an anti-inflammatory cytokine, and a decline in pro-inflammatory cytokines [5]. Therefore, cooling interventions may have an anti-inflammatory response and may be effective in reducing muscle damage, and may therefore enhance muscle recovery. And it also can be utilized to improve exercise performance, sports injury rehabilitation [7].

Strategies to prevent physical fatigue, sports injuries include avoid overtraining. Adequate recovery and various type of rest during and after physical activity and assuring adequate nutrition supplementation such as glutamine, vitamin B, vitamin C, carbohydrate, ion or berry-contain sports beverages is helpful in physically active elderly [16]. Further

study for the intake of sports-related beverages in active elderly people is urgently needed in this area.

Conclusions

For the elderly people, sensory changes, physical weakness, cognitive loss, falls and lung and cardiovascular diseases are prevalent and also difficulties with QOL are common. This is the reason that elderly people must do regular exercise to sustain healthy aging.

Exercise training has been extensively studied about the reduction of inflammation, oxidative stress, disease, and aging in syndrome X patients and elderly.

Combined and aerobic or resistance exercise training could reduce obesity, insulin resistance and hypertension. And also, Exercise training has been extensively studied in cancer settings as part of prevention or treatment strategies.

Regular physical activity has the potential to target tumor growth through regulation of inflammation and immune responses such as lactate clearance, NK cell activation (innate immunity), activation of cytotoxic immune cells, T cell activation (adaptive immunity), and immune surveillance.

However, strenuous exercise not only induces thermogenesis and diverse sports injuries but also elicits mobilization and functional enhancement of monocytes, neutrophils (which is caused by the cytokine changes such as TNF-alpha, IL-1) whereas it suppresses cell mediated immunity leading to increased sensitivity to inflammation and contagions such as cough and URTIs (upper respiratory track infections).

Therefore, Strategies to prevent physical fatigue, sports injuries include avoid overtraining, Adequate recovery and various type of rest during and after physical activity and assuring adequate nutrition supplementation such as glutamine, vitamin B, vitamin C, carbohydrate, ion or berry-contain sports beverages is helpful in physically active elderly.

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초록 : 건강한 노후 : 운동활동과 면역반응을 중심으로

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최근 의공학과 의학기술의 발달로 인간의 수명이 늘어나고 있으며, 이제는 수명에 대한 관심보다는 건강한 노후에 대한 관심에 초점을 맞추어 항노화 산업과 의과학 및 스포츠 과학이 발달하고 있다. 노화의 자연스러운 과정 동안 노인들은 면역기능과 생리학적인 기능이 소실되고, 제2형 당뇨병, 고혈압, 골다공증, 골관절염, 심혈관 질환 및 인지감소 등을 경험하게 된다 하지만 규칙적인 운동을 참여할 때 건강한 노후를 맞이할 수 있다. 하지만 이제 까지 노인들에게 규칙적인 운동활동의 참여가 건강체력, 정신건강, 인지기능 및 면역력의 변화를 확인하는 연구가 부족한 것으로 여겨진다. 따라서 본 연구는 노인에게서 일상생활도 관리 및 규칙적인 운동활동의 참여가 건강한 노후와 면역력유지에 미치는 효과를 분석하고자 한다. 본 연구를 수행하기 위하여 최근 20여년간 국내,외 이 분야에서 수행된 최신 연구결과들은 펩메드 데이터 베이스를 활용하여 비교 및 분석하고자 한다. 본 연구결과 레저활동을 포함하는 규칙적인 운동활동은 노인의 근육량과 골밀도를 증진시키고, 아울러 당뇨병, 고혈압, 동맥경화, 관절염 등과 같은 성인병을 예방하며, 아울러 인지기능 증가에 따른 치매의 예방과 치료 뿐만 아니라 면역력의 증진을 통한 만성질환과 암의 예방에도 필수적인 것으로 사료된다. 특히 노인에게는 요가나 필라테스를 기반으로 하는 수행하기 쉬운 운동이 좋으며, 흥미있고 자주 할 수 있는 운동이 권장된다. 체력이 전반적으로 약하기 때문에 무리한 운동은 오히려 심혈관계의 부담, 항상성의 교란, 및 면역저하를 동반할 수 있으므로, 레저스포츠 활동, 근력운동을 포함하는 저항운동, 및 일상생활도 증가를 통한 체력증진, 충분한 휴식, 최적의 영양관리가 필요하며 추후 건강한 노인에 최적화된 스포츠 장비, 영양소 섭취와 스포츠 음료 등의 개발에 관한 연구가 이루어져야 할 것이다.