

A Commentary Approach to Ambulation  
 and Health Concept (Mechanism)\*

Eun-Hee Noh<sup>1</sup>, Eun-Surk Yi<sup>2</sup>, Ji-Youn Kim<sup>3</sup>, Seom-Gyun Lee<sup>4</sup>

<sup>1</sup>Dept of Exercise Rehabilitation and Welfare, Gachon University, Korea (sneh7078@naver.com), First Author

<sup>2</sup>Dept of Exercise Rehabilitation and Welfare, Gachon University, Korea (yies@gachon.ac.kr)

<sup>3</sup>Dept of Exercise Rehabilitation and Welfare, Gachon University, Korea  
 (eve14jiyou@naver.com), Corresponding Author

<sup>4</sup>Dept of Exercise Rehabilitation and Welfare, Gachon University, Korea (dlxodnr1@snu.ac.kr)

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ABSTRACT

Ambulation is among the most important functions of survival for human as a basic motion very closely related to health as well as having characteristics of humans distinguishing themselves from animals rather than simply as a means of mobility. Ambulatory activities help to resolve complex problems such as obesity and the lack of exercise, yet to the contrary, improper ambulatory motion may cause abnormalities such as those in joints, brain, and body structure, so it is ascertainable as to whether a person is healthy, a patient or has disability. Ambulatory activities also convey the language of gestures and express people's intention and speak for their lives. Such a study of ambulation deals with variables such as ambulatory space, ambulator, ambulatory speed, ambulation analysis, balance, ambulatory skills, ambulatory function, and ambulatory activities across various academic fields of engineering, social science, art, music and physical education, and medicine and pharmacy, gaining attention for over decades. Also, in recent years, as the demographic structure has changed due to the rapid aging of the population, the social interest in health issue connected with physical activity improvements such as ambulatory activities and ambulatory skills of the aged is increasing. However, the analysis of various ambulatory mechanisms is insufficient, so it will be necessary to analyze the correct ambulatory patterns according to gender, age, and disability, and also conduct academic researches of approaching neuromuscular, biomechanical, and motor functional changes. In particular, the ambulatory activities according to the ambulatory speed show a lot of changes according to the age, and these changes may cause injuries such as falls, so studies related to prevention may be said to be very meaningful. Through the process of ambulatory activities, it would be necessary to recognize the importance of ambulation and continue the academic study of the change of ambulation according to the flows of the time. In addition, it will be necessary to suggest directions for correct ambulatory activities to obtain the human ambulatory patterns for health promotion, develop exercise programs which will lead the changes of ambulatory activities in the aspect of exercise function to be applicable to anyone, thereby conducting studies of ambulatory activities of scholarly value extensively. Finally, a suggestion is intended that the ambulatory activities research and exercise program development for the aging population are needed from the perspective of convergence of ambulation while looking at our lives through the ambulatory activities.

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## 1. Introduction

Lucy, the first female human fossil, who stood on two legs 3.18 million years ago and who was found in the Hadar Valley in Ethiopia in 1974, has been regarded as the ‘first human’ to perform an upright ambulation as *Australopithecus afarensis* (Park, 2010). Very likely, from the moment Lucy, the “first human” or “ancestor of mankind,” performed an upright ambulation, ambulation has been recognized to be more than just a means of movement for humans, as it has the character of human beings distinguishing them from animals, and has also been recognized to be a most basic motion, behavior or physical activity closely related to health (Park & Park, 2010).

In fact, since over 100 skeletal muscles must cooperate with upper and lower limb joints to perform ambulation, appropriate ambulatory activities could help resolve complex problems such as obesity and the lack of exercise, whereas on the contrary, may cause issues such as those in joints, brain, and body structure (Scott, 1990; Whittle, 1990).

In addition, ambulation is a primitive language of gestures which makes people aware of whether one is healthy, a patient, or has disability, while always forwarding the meaning of something and expressing the intentions of people, further to speaking about life (Park, 2003). For example, people who have been ambulating for their entire lives would likely suffer from countless sufferings, such as limping due to their body’s imbalance, walking with their shoulders twisted, walking bending their backs forward, etc. On the other hand, those who have always kept the right ambulation could have a healthy life even if their muscles decrease due to aging and the body shape changes to some extent. Accordingly, ambulation can be said to represent our lives and health.

However, the development of mankind has had many negative effects on the human ambulation. Especially after Alvin Toffler’s “The Second Wave: Industrial Revolution,” seating time has increased due to comfortable seating and convenient transportation means, reducing the overall ambulation time (Whittle, 1990). After “The Third Wave: Information Revolution,” the inappropriate ambulatory motion began to bring about changes in the human body. Many of those who have lost their sight to their smartphones or tablet PCs slowed down their ambulation speed and shortened their stride due to their incorrect posture, which have also caused new problems of neck and shoulder pains such as the turtle neck syndrome and round shoulder (Park et al., 2015).

As such, ambulation is a critical factor of human life and health recovery. It is a utilitarian physical activity which occurs naturally in everyday life, and is also a health promoting motion and act available for use anywhere at the cheapest price. Therefore, it is intended to discover the right health mechanism for ambulatory activities in the paradigm of variously changing ambulation and offer them as the basic data of research.

## 2. Key Perspectives on Ambulation Related Studies

Ambulatory activities are among the determining motions of the quality of life for humans to live, which means that they are walking as defined by books, and are moving the center of the

body by maintaining the stability in the standing posture and the complex and continuous movement of multiple joints and muscles (Phil et al., 2012). Such a study of ambulation deals with variables such as ambulatory space, ambulator, ambulatory speed, ambulation analysis, balance, ambulatory skills, ambulatory function, and ambulatory activities across various academic fields of engineering, social science, art, music and physical education, and medicine and pharmacy, gaining attention for over decades. In recent years, as the demographic structure has changed due to the rapid aging of the population, the social interest in health issue connected with physical activity improvements such as ambulatory activities and ambulatory skills of the aged is increasing.

A lot of studies have been conducted on the issue of ambulatory activities (Spiriduso et al., 2005; Maki & Mciloy, 1996; Gallagher et al., 2001; Wolfson et al., 1995; Fukagawa et al., 1995), and their main focus was to find the cause of the decline of ambulatory skills in elderly people, decrease of the balance (sense of balance), decrease of the skeletal muscle mass, and decrease of the strength of the leg muscles due to aging and the lack of exercise have been noted as the cause of the declining ambulatory skills (Shimada & Uchiyama, 2001; Tsuritani, 2001). In particular, the issue of the ambulation of the elderly is largely affected by the lack of ambulatory activities related to the increase in age and exercising habits, so the ambulatory education focusing on disease prevention ought to be accompanied by the health promotion's effect.

Recently, the left and right imbalance due to ambulation is apparent in normal people as well as those with physical disabilities (Park, 2012), and most of the imbalance due to ambulation is known to be attributed to the acquired lifestyle for wrong lifestyle rather than congenital physical function issues (Kang, 2017). However, there are still a few studies to provide a systematic education for the subjects who need to change their ambulation habits and be educated on the right ambulatory function.

Consequently, it will be necessary to analyze the correct ambulatory patterns according to gender, age, and movement through the motion of the human body, which is essential in everyday life, and identify the relationship with health promotion through ambulatory activities by approaching neuromuscular system, biomechanical and motor functional changes.

### **3. Functional Mechanism of Ambulation**

#### *3.1 Mechanism of Ambulation*

Ambulation is a most frequent motion apparent in everyday life, and also plays such a large role for independent movement at home and local community. Ambulation makes advancements via repetitive crossing movements of the legs and also generates propulsion while absorbing shocks appropriately (Jo & Kim, 2012; Hamill et al., 1984). In addition, ambulation is a complicated process which smoothly shifts the center of the body while well coordinated mechanical movements occur concurrently in many joints of the lower extremities (Perry, 1992). As such, ambulatory activities involve a number of factors, so they have unique characteristics depending on the function of the individual's muscles, skeleton, and nervous system (Feber et al., 2002). In particular, as the age

grows, the sense of balance declines, muscular strength decreases, and ambulatory skills decline, and so the ambulatory pattern changes as well (Hahn et al., 2005).

As such, to clarify the mechanism of ambulation which may be caused by various and complex factors, studies have been conducted on the infants through the elderly, normal people, those with physical disabilities, pregnant women, workers at industrial sites, working men, obese people and athletes, and the contents of the studies are various and wide ranging such as ambulatory activities' efficiency, stride, symmetry, attitude change according to speed and load, ambulatory pattern, and ambulatory analysis.

In addition, ambulatory activities are divided into normal ambulation and abnormal ambulation via various methods of analysis, so the changes in the ambulatory mechanism and ambulatory pattern may be affected by the restricted role of the human body. The factors affecting normal ambulation include angular movements of the lower limbs, muscular activation, load, and body center's movement, and diseases or injuries of the nervous system and musculoskeletal system interfere with the normal ambulation. Abnormal ambulation is a lot more energy consuming than the normal ambulation and may also cause various diseases due to joints, muscles and body structure from physiological and epidemiological perspectives. Therefore, much effort has been made to diagnose and determine the ambulatory imbalance due to abnormal ambulation, and it has been consistently developed across various fields ranging from various measurement tools and methods related to the ambulatory analysis and research using mathematical techniques.

As such, ambulatory activities may be different depending on the extent of various pathological conditions and such various external environments as the ambulatory environment, so it is necessary to continue academic researches to help the ambulatory activities by analyzing the correct ambulatory mechanism.

### *3.2 Ambulatory Skills and Health Prediction Skills*

Ambulatory skills mean the mobility required to carry out everyday life, which can predict to what extent a person maintains normal life (Koretz & Moore, 2001), and can also predict the risk of injuries and falls (Ludebjerg, 2001; Granacher et al., 2011; Scanail et al., 2011).

Ambulatory skills are explained by measuring the ambulatory speed. The ambulatory speed of the elderly largely affected by changes is 1.3% of the ambulatory speed of the normal elderly, but the ambulatory speed of the general adult is 1.4% (Neumann, 2004). To achieve safe ambulatory activities, stability and balance ought to be maintained with appropriate ambulatory speed through the interrelationship with the lower extremities, pelvis, trunk, and upper limbs, and the center of the body ought to be shifted. O'Loughlin et al. (2009) claimed that a main factor of the ambulatory skills was the dynamic and static stability of the ankle joints, and that the differences in ambulatory skills were most closely related to the ankle injuries which arise while exercising or playing sports.

Consequently, ambulatory skills are not just a function which helps to move our bodies, but also an important factor in predicting the risks of injuries and falls in our daily lives and injuries which arise during the exercise or while playing sports. Ambulatory speed is also one of the most

important measures for predicting functional performance, which is closely related to the post stroke disability level (Schmid et al., 2007).

Until now, researches on ambulatory skills have shown that most of the studies focused on the elderly people with problems of muscular strength and balancing skills. Wolfson et al. (1995) reported that the muscular strength of the lower extremities of the elderly are closely correlated to the ambulatory skills and balancing skills, and Fukagawa et al. (1995) reported that the muscular strength of the lower extremities, when weakened, causes the ability to climb stairs to decline, which further reduces the physical activity participation and slows down the metabolism inside the human body while declining the muscle mass. As such, their relationship has been proven by previous studies conducted on the issues of ambulatory skills and the balancing skills caused by the declining muscle mass of the elderly. In addition, maintaining low muscle mass and bone density during the adulthood may be considered as a major cause for the declining ambulatory skills and balancing skills as they adversely affect the physical strength during the old age.

Therefore, there seems to be a correlation between ambulatory skills and health promotion, and studying specific exercise programs for improving muscle mass and bone density in terms of ambulatory activities will be helpful.

### *3.3 Ambulatory Activities' Exercising Effect in the Context of Preventive Medicine*

Ambulatory activities are one of the most fundamental motion activities performed by humans on the face of the earth, which may be said to be characterized by a form of complicated exercise consisted of neuromuscular, biomechanical and motor functional changes in movement (Andriacchi et al., 1980). Recent studies have also shown an interest in the effect of exercise on the long-term ambulation performed (Stolwijk et al., 2010).

Moderate ambulatory activities have been reported to have positive impact on cardiovascular and metabolic skills enhancements (Haddock et al., 1998; Morris & Hardman, 1997). In addition, ambulatory activities, which can be easily performed by everyone including the young and old, are popular across the globe for promoting health, further to facilitating the body's metabolism to increase immunity and prevent osteoporosis, as well as prevent back pains, joint pains, adult diseases (Shono et al., 2001).

As such, as ambulatory activities are highlighted and studied as a sustainable means of movement, ranging from the physical health variables of the elderly (Hwang et al., 2009; Ko, 2010; Lim et al., 2009) to mental health (Han et al., 2011), and to the middle aged women's physiological index (Hyoung & Kim, 2008; Yu et al., 2010), active lifestyle carrying out ambulatory activities in terms of individual health promotion and prevention is encouraged. Since it is well known that those who practice ambulatory activities usually have a longer life span of health and are effective in preventing diseases such as cardiovascular diseases, diabetes and obesity, ambulatory activities which can be performed anywhere in daily life should not be neglected.

Ambulatory activities are an easy exercise for promoting health, and when carried out with close acquaintances, a forum of communication is created, and an additional effect of communicating from an objective and positive perspective is recognized to be important. It

also assigns a means of purifying the mind in a way as to resolve conflicts and anger in the mind in daily life.

Accordingly, the development of facilitation strategy for ambulatory activities which emphasizes various mental, emotional and social effects and meaning ought to be stressed from the perspective of preventive medicine, so that more opportunities for ambulatory activities through a greater number of participants should be offered.

### *3.4 Ambulatory Activities and Holistic Effect from the Health Perspective*

Recently, many studies have attempted to evaluate and improve ambulation from the functional perspective of human movement (Phinyomark et al., 2018). Studies are also aimed at improving physical health and mitigating musculoskeletal disorders through quantitative ambulatory analysis (Hunt & Hatfield, 2017). However, given the complexity of the ambulatory motion and the variability of human motion, it is not easy to generalize and apply the data.

A study of the relationship between ambulatory activities and health (Kim, 2002; Kim et al., 2004; Lee et al., 2006) reported that ambulatory activities, when performed for a certain period of time, help to reduce obesity and enhances health and physical strength.

In addition, in a study conducted using the national health and nutrition survey data (Sung, 2009), examining the relationship between ambulatory activities and health related indicators showed that the amount of ambulatory activities continuing for over 10 minutes helps to reduce the prevalence of obesity and chronic diseases relative to those who do not perform ambulatory activities as a matter of empirical analysis. Such a health promotional effect is represented higher than mid to high intensity physical activities, so it implies that ambulatory activities are playing such a critical role for health promotion.

Consequently, ambulatory activities contribute to health promotion through physical activity promotion, and ambulatory activities intended for to traveling purposes are not at a negligible level in terms of the adults' extent of physical activities (Cerin et al., 2007). Even in the most previous studies, it was found that the ambulatory activities of exercising purpose positively impact the physical activity promotion and health, so not only for ambulatory activities, but also are effective for the physical activities and skills, and the ambulatory activities and continued comparative and analytical studies must be continued.

However, studies which show the relationship between ambulatory activities and health already have a lot of analytical results derived from the existing ambulatory exercise programs, so subsequent studies quantitatively assessing health effect must be consistently performed.

### *3.5 Value of Ambulation Studies in the Aging Society*

Given the recent rapid aging of population and the changing demographic structure, the ambulatory issues of the elderly are gaining social attention. Ambulation is a most basic motion of daily life which helps people to live independently, and it has been reported that ambulatory skills are degraded more proactively than other activities of daily life (Tainaka & Aoki, 2002).

The prevalence of multiple chronic diseases, osteoporosis, metabolic syndrome, and arthritis most representative in the aging population is consistently rising (Korea Centers for Disease Control and Prevention, 2015), and in the case of aged women, opportunities for social activities are less and accordingly, their physical activities have declined, causing post menopause bone density to decline, mobility skills to decline, and muscular and joint functions to decline, among other apparent issues (Wilkerson & Rose, 2008). As a result of which, they retain chronic diseases, causing declines in physical functions, and further repeating the vicious circle of being exposed to the diseases again.

As such, the declining physical function caused by aging affects the falls which comprise the highest frequency among the elderly's injury factors. Examining the previous studies of the ambulation of the elderly, it was reported that the variability of the ambulatory variables over time and space, such as stride or walking speed, is a measure of regular movement's control, and the failure of control increases the risk of falls (Hausdorff, 2007). Furthermore, the physiological body functions decrease as well as the postural control skills decrease, resulting in changes in the ambulatory posture and instability (Barau'na et al., 2004; Kim, 2007; Tainaka et al., 2009; Park & Jung, 2012). Such postural imbalance and ambulatory function's abnormalities are also reported to be a cause of increasing the probability of falling for the elderly, and the fractures accompanying the falls largely impact the death of the elderly (de Noronha et al., 2011).

Accordingly, many previous studies over such a long time have indicated that regularized exercise not only prevents the elderly's musculoskeletal diseases but also is conducive for preventing falls (Baker et al., 2010; Kwak et al., 2016), and specifically, it is known that it induces positive effects for physical factors such as increased muscle mass, balancing skills, and ambulatory skills improvement (Englund et al., 2005).

Moreover, since physical strength for the elderly is closely related to the balancing skills, strengthening the muscular strength is essential for improving the balancing skills (Skelton & Beyer, 2003). Exercising programs are recommended for improving muscular strength for ambulation as an effective method of improving the ambulatory stability for the elderly (Kenny et al., 2011), regularized exercise is reported to help improve the muscular strength of the lower extremities and body balance of the elderly and also prevents and enhances the stability issue of ambulation (Gauchard et al., 2003; Yeom et al., 2009).

Ambulatory activities are recommended for the patients and the elderly with obesity, cardiovascular, endocrine, and orthopedic diseases, and are also used as proactive kinematic therapies (American College of Sports Medicine [ACSM], 2009; Korner & Eberle, 2001; Oakley et al., 2008; Shono et al., 2001).

Therefore, in the age of aging, the elderly ought to have a consciousness for health through ambulatory activities themselves, and specific and objective exercise programs helpful to prevent and improve falls through balancing and ambulatory skills must be continuously disseminated and developed.

## 4. Discussion

Human's upright ambulation is a most fundamental movement which is completed by the development of the nervous system and the musculoskeletal system along with training over a long period of time, and is distinguished from animals. Ambulatory activities aim to maintain posture and balance in line with the centerline of the body while the body is in motion. We must recognize the importance of ambulation through such process of ambulatory activities and also continue the scholarly studies of ambulatory changes following changes of the times.

In addition, to obtain the ambulatory pattern of humans for health promotion, directions for appropriate ambulatory activities' culture would need to be presented, and exercise programs to lead changes of ambulatory activities will need to be developed. Ambulatory education of scholarly value which can be practically applied to everyone will be required.

"Men walk. Therefore, they exist." Is this not an expression of sublimity of ambulation? Walking for humans assigns meaning to a living life, and the ambulatory activities make us realize how important it is to human life and health recovery as a physical culture.

Consequently, we would like to suggest that continuing studies of ambulatory function for the aging population and the development of programs for the ambulatory activities are required from the convergence perspective of ambulation as a result of commentary exploration.

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