A Thesis
For the Degree of Doctor of Philosophy

The Analysis of Body Conformation and Gait Characteristic of Riding Horses

Tae-Jun Kwon

Department of Biotechnology

GRADUATE SCHOOL
JEJU NATIONAL UNIVERSITY

Fabruary, 2015

The Analysis of Body Conformation and Gait Characteristic of Riding Horses

Kwon, Tae-Jun

(Supervised by professor Min-Soo Kang)

A thesis submitted in partial fulfillment of the requirement for

the degree of Doctor of Philosophy

2015. 2

This thesis has been examined and approved by

Thesis director, Professor Kyu-Kye Hwang, Ph. D. College of Veterinary Medicine, Jeju National University

Professor Han-Jong Ko, Ph. D. Dept. of Agricultural Sciences, Korea National Open University

MoonSuck Ko, Ph. D. Subtropical Animal Experiment Station National Institute of Animal Science, R.D.A

Yong-Joon Han, Ph. D. GSP center, Forestry&Fisheries, Agriculture, Korea Institute of Planning &Evaluation for Technology in Food

Professor Min-Soo Kang, Ph. D. College of Applied Life Science, Jeju National University

Department of biotechnology

GRADUATE SCHOOL

JEJU NATIONAL UNIVERSITY

ABSTRACT

The horse industry encompasses business sectors that are derived from horse breeding, horse racing and horseback riding. In South Korea, Jeju Island has been recognized as a selected place for these sectors even though several provinces of South Korea have bred horses. Presently, around 66% of farms that raise horses are located on Jeju. Jeju also occupies 77% of the total raised horses in South Korea. The bred qualified horse for horseback riding is an important sector of the horse industry. However, studies that describe cross breeding for horseback riding have been insufficient. Thus, this study describes the conformation and gait traits of horses. The accumulated data were used to select appropriate horses for horseback riding and recreational horseback riding therapy (HBRT).

Ninety-six horses were measured and classified and for groups of horses were eventually categorized. The groups were designated into four types of horses. Type 1 has a short body and narrow chest width (SN). Type 2 has a short body and wide chest width (SW). Type 3 has a tall body and narrow chest width (TN). Type 4 has a tall body and wide chest width (TW). In the walking test, the longer length, duration, current cycle and since cycle were observed in Type 1 and Type 2 with a horse rider and in Type 2 only without a horse rider. Alternatively, length, duration, current cycle and since cycle of walking were the shortest in Type 4 with and without a horse rider. Most other results for stand up trot and sit trot were similar. The length, duration, current cycle and since cycle of the jog trot were the longest in Type 1 and Type 2 with a horse rider. An analysis of Type 3 and Type 4 showed less length, duration, current cycle and since cycle of the jog trot in comparison to Type 1 and Type 2. Type 2 horses revealed the fastest acceleration in walking, sitting trotting and stand up trotting. Type 4 showed the slowest acceleration for all of the tests. The highest frequency rate of rebound was observed in Type 4 when accessing the oscillation of a classified horse. Based on the collected data, rehabilitation was evaluated and the best score was assigned to Type 4 for the HBRT.

Consequently, showing short-distance jog gait, duration, current cycle and since cycle of Type 4 horses with less acceleration and considerable frequency may be suitable in the HBRT. Therefore, this study expects that the selected Type 4 horses can be suggested as a standard for horses bred for horseback riding on Jeju. Moreover, further studies are needed to validate these finding and measure correlation analysis of gait trait and rehabilitation in type 4 horse.

KEYWORDS: Riding horse; Body conformation; Reboud check; Gait; Jeju crossbreed horse; horseback riding

LIST OF TABLES

PAGE

LIST OF FIGURES

LIST OF APPENDIX

PAGE

BACKGROUND

The Horse Industry in Korea

A definition of the horse industry should be described and supported by the horse industry itself. Figure 1 depicts this industry, demonstrating every economic activity associated with it, including the production, raising, training, distribution and use of horses; it also includes other sectors derived from these activities including horse racing and horseback riding.

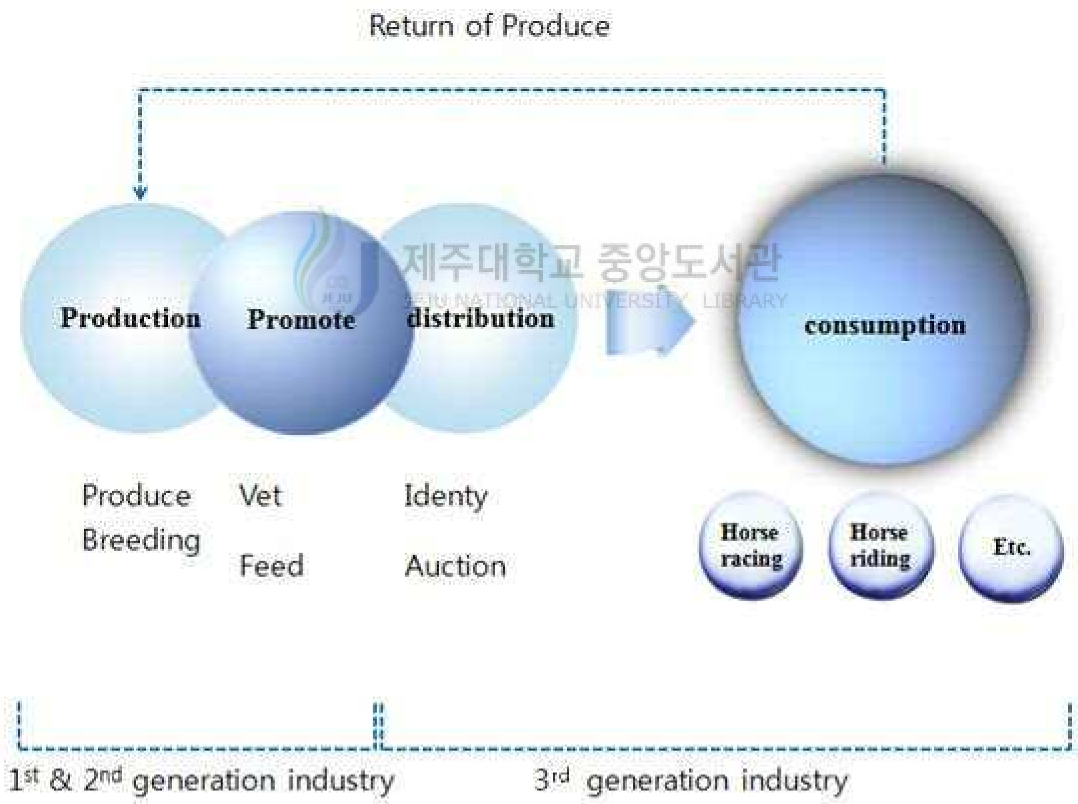


Figure 1. The horse industry is the primary industry of a tertiary industry convergence of associated industries (Horse Industry, KRA. 2012).

Property and Status of the Horse Industry

Horse are distinctive domestic animals in contrast to other animals that are raised for food. In the past, the horse existed as an edible source and was employed in diverse activities, including as a companion animal. Horse racing and horseback riding have been the two most popular activities associated with horses, which have a long history of human use. Horseback riding is highly prized in the sports arena because it allows communication between humans and animals in order to improve and achieve mental and physical conditioning. In addition, horses are present in tourism, sightseeing and therapeutic rehabilitation with other animals.

Over the past few decades, domestic animals have created environmental issues, such as methane gas production, which is considered to be a major contributor to the greenhouse effect. Thus, it can be said that animals producing methane gas have harmful effects on the environment. Dairy cattle, Korean native cattle, pigs, horses, sheep and goats are known to be major sources of methane gas. By comparison, the horse is an environmentally-friendly animal.

The home-based production of horses provides an advantage in raising horses because of the many strict conditions on the global horse industry. Blood and quarantine maintenance is stringent, and importers have to meet exorbitant costs in the horse trade. This situation provides an advantageous position for home breeders when the market is open.

Economic Status of the Korean Horse Industry

The 2market scale of the horse industry in Korea is estimated to be trillion 870 billion Korean Won (KRW) directly and 697.8 billion KRW indirectly. In 2009, this market scale occupied 0.22% of the gross domestic product (GDP) and 9.2% of the GDP for agriculture, forestry and fisheries. Production inducement coefficients were 0.82

for production, 0.63 for horse ownership, 0.28 for horse racing and 1.04 for horseback riding. Therefore, horseback riding is a noticeably high sector in the horse industry. Specifically, 1 million KRW is produced from horseback riding, and 1.04 million KRW is derived from associated businesses. In particular, the financial value of thoroughbred horses averages around 120 million KRW, with a derived value of 4.9 million KRW annually for the past twenty-five years (Horse Industry, KRA, 2012).

Recent Trends in Korea's Horse Industry

Recently, the government of Korea has provided affirmative support to the horse industry, thus strengthening institutional strategy in promoting the horse industry further. An enacted policy on the support of the horse industry secures continued policies for the development of the horse business. The policy includes the revitalization of horseback riding with the promotion of employment. Meanwhile, a local autonomous entity is also promoting the horse industry and developing a program for horseback riding. Furthermore, professional education courses have been developed in high schools and higher education institutes, such as technical colleges and universities.

Fortunately, the awareness of those who are not concerned with horseback riding has been awakened through higher attendance at events involving horses. In addition, demand for experienced horseback riding businesses have increased, and recently, five youth horseback riding teams have been established.

Details of the Act Supporting the Horse Industry

To scientifically develop the horse industry, the enacted comprehensive plan must be renewed every five years. The plan must include directions and goals for horse businesses, plans for supply and demand, development of techniques, plans for professional human resource education and designation of a special area for businesses associated with horses. Subsequently, inspections encompassing human resources and facilities to meet requirements of the act should be completed so that appropriate organizations can be appointed, thus allowing the plan to run smoothly. In order to be designated as an optimal institution, the institution should have five hired veterinarians, 1,500 square meters per playground and 1,000 meters of main road. The educational plan has introduced a horse-associated certification and designated entitled education centers to train professional human resources. The Korea Racing Association's (KRA) research centers, associated with the horse industry, high schools, colleges and universities, could be candidates for education centers. All institutes to be selected have been evaluated for their curricular details. Thus, it is expected that a qualified horse trainer, farrier and instructor in HBRT will be produced. At the same time, experts can share their knowledge regarding potentially talented personnel. An examination for a horse trainer, farrier and instructor in HBRT will be administrated, including theory and practice testing.

Policies regarding horseback riding facilities based in rural areas have been adapted. Rural facilities will be approved after satisfying several conditions. Essential to approval are three horses, 500 square meters with stables and accessory structures, and documents explaining the installations. Submission of papers to the self-government director is necessary to have a business that employs horses for horse production, breeding and riding. In particular, a settled area for the horse industry is possible through an approved special region. The area will be an outpost for the horse industry, which could lead to economic benefits for a rural area. The special area will be an industrial complex to support multiple businesses associated with horses. The submission will be carried out by a local autonomous entity, and the qualifications are listed below. To be such an outpost, an area must have an existing 50 farms, facilities to breed 500 horses, 2 billion KRW of sales scale and installations that includes horseback riding, training and education.

The Current State of the Horse Industry in Korea

Horse Husbandry and Consumption

A 2009 report noted that 28,718 horses were raised on 1,742 farms in Korea. These horses occupied 2% of the total stockbreeding at farmhouses. Among the raised horses, the number of race horses or horserace associated horses was about 6,000, and the number of horses for horseback riding was about 5,000. There were 900 horses consumed for food meat annually. Unfortunately, the raised horses for horseback riding were not intentionally raised for this specific purpose even though racehorses were specifically raised and trained on 187 farms with an estimated 1,300 horses total per year. In fact, the horses used in horseback riding were imported of extra remnant horses that were raised on farms. The horses consisted of 47% thoroughbred, 12% warm blood and 35% pony. The horses were 67% domestic and 27% imported (Figure 2).

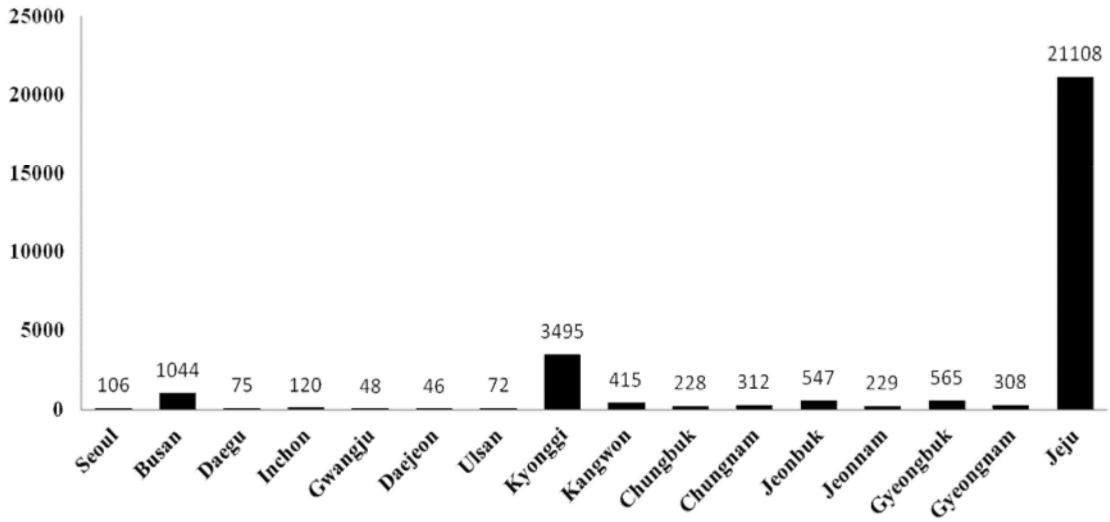


Figure 2. Horse breeding conditions in Korea from 2000-2009 (Horse Industry, KRA).

Jeju is known as the best place to breed horses in Korea. Presently, 66% of the farms that raise horses are on Jeju, and raised horses bred in Jeju occupy 77% of the total horses in Korea. Thus, Jeju is a core base of horse production (Tables 1 and 2). On a year-by-year basis, the horses bred in Jeju have increased. According to research, farms located near Seoul and neighboring Gyeonki-do have relocated to Jeju, and this phenomenon will continue for several years. At the same time, farms which once raised other animals have begun to raise horses. Thus, the optimal environment of Jeju attracts farmers that raise horses, and the prospective horse industry in Jeju continues to draw more attention from farmers. Jeju is 48% grassland and has optimal weather conditions and infrastructure for horse-rearing, causing many farmers to decide to breed horses in the Jeju special self-governing province.

Table 1. Horses breeding conditions with number of farms and horses (2012).

Variable	Number of breed				Korea
	Total	Je Ju horse	Je ju crossbred horse	Thoroughbred	
Number of farm	1,157	320	662	175	1,917
Number of horse	22,233	1,362	16,692	4,179	30,402

Table 2. Horse breeding conditions in Jeju from 2007-2010.

Variable / Species	'07. 12	'08. 12	'09. 12(B)	'10. 12(A)	Variation (B-A)	B/A (%)
Number of horse	12,526	14,660	15,209	15,921	-712	-4.5
	-542	-660	-715	-787	(-72.0)	(-9.1)

The International Horse Industry

Japan

Japan defines the horse industry as all businesses that encompass horse racing and horseback riding. The number of breeding horses in Japan is estimated at approximately 93,000. There are 964 registered horse riding clubs and approximately 66,260 club members. In 2006, the economic effect of the horse industry on Japan's economy was estimated at 8.6 billion dollars. With a GDP of 4,340.1 billion dollars in 2006, the industrial value of horse businesses was about 0.2% of the total GDP of Japan (KRA, 2010).

Australia

Australia simply defines the horse industry as all businesses using horses, which includes sports and recreation. The estimated number of horses bred in Australia is approximately 1,200,000. 400,000 are wild horses, 316,000 are horses used in agriculture, 26,251 are mares and 850 are stallions. There are 17,618 registered members in horseback riding clubs and 70,000 registered riding horses. In addition, there are 61,819 members in pony horseback riding clubs. The economic value of the horse industry in Australia was estimated at 6,300 million dollars in 1999. With an estimated 1999 GDP of 418.8 billion dollars, Australia has a horse industry valued at 1.5% of its GDP (KRA, 2010).

The United Kingdom

The United Kingdom (UK) defines and classifies the horse industry according to the following concepts: professional, intermediate and leisure horse and riders. The classifications include ownership, production, racing, facilities for horseback riding education, tracking, horse shows, horse races and the training of riders and horses.

Approximately 0.6 - 1 million breeding horses are reported for the UK, and 5 million people are interested in the UK horse industry. If those who watch horse racing on television are included, the estimated number of people employed in the UK horse industry may reach between one million to one billion people. There are 50,000 direct employees and 100 - 200,000 indirect employees of the UK horse industry. The horseback riding population is estimated at 2.4 million. Thus, the horse industry contributes 3,400 million pounds (5,780 million dollars) to the UK economy. This number equals 0.26% of the UK GDP in 2005, which is 2,218 billion dollars (KRA, 2010).

Germany

Germany defines the horse industry in terms of all businesses that encompass horse racing and horseback riding. In Germany, there are around one million reported bred horses and 7,637 registered riding clubs. Germany has a record, holding 65,969 horseback riding competitions with 1,409,834 competition participants. The population of horseback riders is estimated at 1,600-1,700 million, including 753,710 registered club members. The horse industry in Germany creates 300,000 jobs and contributes 5 billion euros (7 billion dollars) to the German economy. The GDP of Germany in 2006 was estimated at 2,906.7 billion dollars; the horse industry composes 0.24% of the GDP of Germany (KRA, 2010).

France

France defines the horse industry as all businesses that encompass horse racing and horseback riding. The number of horses raised in France is estimated at 452,000 with 6,397 existing horseback riding clubs. 24,630 horseback riding competitions are held annually with 679,799 in attendance. Thus, there are 1,500 thousand horseback riders and the 523,619 members in horse riding clubs. Around 67,000 employees are associated with and hired by the horse industry and 10 billion euros (13 billion dollars) is contributed to the economy of France. The GDP of France in 2006 was 22,307 billion dollars and the economic effect caused by the horse industry shares approximately 0.58% of the GDP of France (KRA, 2010).

Austria

Austria defines the horse industry as all businesses that involve horse racing and horseback riding. There are 100,000 bred horses in Austria, resulting in 24,000 jobs. In 2006, there were 11,309 farmers, generating 1.26 billion euros (1.76 billion dollars) for the economy of Austria. This figure was 0.55% of the GDP of Austria in 2006, which is 322.4 billion dollars (KRA, 2010).

The United States

The United States (US) defines the horse industry as including agriculture, business, sports, gambling, entertainment and recreational activities. This definition includes horse races, horse shows, and other types of recreation with horses and miscellaneous usages (e.g., agriculture, rodeo, working, polo and policing). Approximately 9.2 million horses are raised in the US, including 844,531 race horses, 2,718,954 show horses, 3,906,923 recreation horses and 1,752,439 miscellaneous horses. Roughly 4.6 million individuals are associated with the horse industry, which includes horse owners, workers, service suppliers and volunteers. In addition, the horse industry creates 1.4 million employees in which 453,612 are full time and 701,946 result from direct hiring. Reportedly, there are 2 million owners, resulting in an estimated 101.5 billion dollars of distributed economic effects from the horse industry with a direct contribution of 38.8 billion dollars. Thus, the horse industry composed 0.81% of the GDP value for the US in 2005, which is 1 trillion 2,470 billion dollars (KRA, 2010).

Horseback Riding

Horseback riding is a very attractive sports activity in which a rider sits atop the horse. Some regard horseback riding as beautiful magic. The rider steers the horse by manipulating his or her leg pressure and hands, which control a bridle. The rider’s appropriate operation provides a message to the horse, and the horse follows the rider's orders. Leg pressure is applied to drive the horse. Hands control the bridle connected with a bit role to steer the horse. In addition, balancing the rider's weight on the saddle also gives signals to the horse regarding speed regulation and rotation. To apply these skills effectively, the rider and the horse need to be trained (KRA, 2010).

History of Horseback Riding

The history of the horse is longer than the history of humans. Appearing in the Mesozoic Era (around 600,000 years ago), the horse has undergone extensive evolution. The appearance of the ancient horse probably differs greatly from today’s horse. Humans that lived in the pre-historic ages hunted horses. However, humans eventually recognized that the horse was a useful animal with diverse purposes. Therefore, modern day humans began to catch the horse and train it, resulting in the ability to move to faraway places more easily. Modern day humans were able to obtain a higher amount of labor from the horse than labor from humans. Horseback riding may have started during the same era of domesticating the horse to such purposes. After the adaptation of the horse, humans may have understood the requirements of developing horse training techniques. These efforts paved the way for horseback riding as we know it today.

There is evidence that horseback riding in ancient times developed in the Mesopotamian Era. According to historians, the Greeks started European horse riding with the four-horse carriage in the 25th Olympics in 680 BC. However, true horseback riding, meaning a person riding on a horse's back, appeared in the 33rd ancient Olympics in 648 BC. Horseback riding has since improved in many European countries. In the middle of the 19th century, "Bose" established modern equitation. Horse riding in Europe was the exclusive domain of the wealthy class. However, circumstances changed as horse riding became a modern sport. In 1912, the Federation Equestre Internationale (FEI) was established in Paris to unite world equitation. Finally, horseback riding was adopted in 1900 as a formal Olympic sport during the 2nd modern Olympics in Paris.

Origin of Horseback Riding

In Greek, a horse is named *hippos*; in Latin, it is *equis*. The term *horse* originated from *equis*. These Greek generally indicate "doing something with a horse, considering a horse and of a horse. The word *equestrian* is understood to mean "a man riding a horse." Additionally, *hippophile* in Greek means "people who love horses." In the past, a hippophile was a type of riding club. Naturally, horseback riding is a distinctive exercise that requires a live horse. Furthermore, an important condition is the sense of unity between human and horse. Since ancient times, horse riding has existed as a life sport to develop strong spirits. Recently, individuals who suffer from stress due to modern life are seeking a return to a simpler life. Because horseback riding allows exercise with live animals, it can provide an alternative activity to relieve stress. Horseback riding is a sophisticated, rough exercise that develops muscle in the entire body. Horseback riding stimulates the minor muscles and bodily sensors in charge of balance and flexibility. Furthermore, horseback riding helps to strengthen the human spirit in terms of boldness and soundness. Individuals may develop a respect for life because of the sharing an activity with a live animal.

History of Korean Horseback Riding

In Korea, horses have been used since the Kojoson Era. However, formal records suggest that the common use of the horse in Korea started during the Three Kingdom Era when horses were used for faster transportation and warfare. The chronicles of the three kingdoms describe the existence of a number of cavalries and horses. The ancient Korea era essentially regarded the horse as a tool for transportation, communication, hunting, agriculture, weddings, gifts and trade. Consequently, dressage was developed on the Korean peninsula and became an important subject for the military service examination, constituting six of twenty-four subjects on the service examination. In particular, a primary theme of the time was a technique using sword and lance on the horse. These skills were demonstrated to King Gwang hae 11 in 1619 and invited from Ieyasu Tokugawa from Japan in the king Inn-jo 12 era during 1634. The dressage skill of our forebears was considered to be excellent. King Inn-jo demonstrated that dressage in Japan was a common issue at that time, recording the strong dressage skills of Korean forebears in the book *Japan Horse Technique History*. Korean dressage remained an expert technique until the middle of the 18thcentury.

At that time, horses were short in appearance, resembling the present day Jeju horses. Unfortunately, interest in the horse in Korea waned in the 19thcentury, and there were only 8,000 horses. Horseback riding as a sport was not introduced in Korea until 1898 by a missionary. One type of horse race was the donkey race, which was intended to introduce excitement to students that attended sports meetings. However, the donkey race disappeared in the 1900 sand dressage was succeeded to the military service. A cavalry regiment was established on November 29, 1900. Students in military school were trained in the skills of dressage beginning in April 1901. The skills of dressage became the basis of horseback riding. Specifically, horseback riding started with donkey racing and was developed by students and soldiers as part of civilized culture. Nonetheless, the circumstances were unstable due to the Russo-Japanese War. Japan eventually won the war, and a secret treaty was signed between the United States and Japan. The secret promise included transferring sovereignty from Korea to Japan. Under Japanese imperialism, the cavalry of Korea was barely maintained, and the public held demonstrations of dressage. However, the hegemony of the Korean cavalry was finally transferred to Japan with the abolition of military service and military school in Korea on July 31, 1909. Japan's annexation of Korea occurred on August 29, 1910.

A patriotic young man tried to boost the morale of Korea by holding a sports competition that included horseback riding. However, horseback riding was not a common sport. Civilized persons, such as the enlightened Japanese, officers from the Japanese Government-General of Korea and military officers were interested in horseback riding. They established the horse riding club "Ma Gi Sul Kyu Sub So" at Supyo-dong, Seoul in 1913, which became the first horse riding club in Korea. The riding club was relocated to the Uljiro 5-ga, Seoul and renamed "Kung Sung Sung Ma Gu Rak Bu." The club members were mostly Japanese, but historically, the club is considered to represent the first of its kind in Korea. Around that time, the members began to enjoy horse racing. The members established horse riding, which was achieved after the First Independence Movement in March. An equestrian competition was held in Euljiro 5-ga, Seoul on May 30, 1920. The events during the equestrian competition were horse training, horseback gymnastics and show-jumping. In the 1920s, the horsemen focused on dressage and horse racing. In February 1919, the Joseon Athletic Association, built by the Japanese, was established. The Association held the first athletic competition, which continues to the present day as a national sports festival in Korea. In July 1920, the Joseon Athletic Association built by Korea was established, which became the present day sports council in Korea. Eventually, the Korean Student Dressage Association was established in September 1945. Simultaneously, the Korean Equestrian Federation was officially launched in October 1945. In 1948, there were numerous attempts to attend the Olympic Games, but the Korean Equestrian Federation was unable to meet this goal because of budget limitations. Afterwards, Korea's horseback riding team participated in the 15^{th}Helsinki Olympics. Subsequently, the team from Korea attended the 17th Rome Olympics in 1960 and the 18th Tokyo Olympics in 1964. Unfortunately, attending the Olympic Games was suspended for several years. Afterwards, governmental support for sports promotion facilitated attendance of Korea's team in the Olympic Games. Korea's teams were able to participate in the 24th Seoul Olympics in 1988, the 25th Barcelona Olympics in 1992 and the 28th Athens Olympics in 2004.

Recreational Horseback Riding Therapy (HBRT)

HBRT attempts to heal disabled individuals with physical handicaps, as well as intellectual and developmental disabilities. This approach is expected to improve life quality via experiences with horses offering pleasure and happiness. The horse allows movement in the body, and individuals receive pleasure from riding horses. Furthermore, the live animal can communicate with individuals, giving them a greater sense of well-being. These influences during horse riding provide confidence, emotional security and humanity to disabled individuals.

Horse gait is believed to be similar to human walking. During horse riding, an intuitive sense from the horse to the human dynamically influences the human nervous system. This process induces a motor response from the cerebrum, a reflex seen in normal humans. Meanwhile, a sophisticated response of the horse induced by human manipulation also creates communication between the horse and human being. These continued reciprocal signals provide a disabled person the experience of motion sensation. In particular, horse riding is a balancing exercise, and thus, stimulates a balancing sensor in the human. The stimulation of the balancing sensor in a disabled person may act to correct incorrect perceptions in the sense of balance, a concept known as "compensatory balance." Specifically, compensatory balance counters the incorrect balance of a disabled person and generates the sense of balance in the cerebrum seen in a normal person.

The History of HBRT

Ancient Greek literature from 400 B.C. describes the suspected rehabilitative effects of horseback riding. One excerpt tells the story of an injured soldier whose condition improved after horseback riding. In more recent history, horse riding was used in the rehabilitation of injured soldiers who participated in World War II. The rehabilitation aimed to heal injuries, provide emotional comport and give psychological security to the physically disabled. In modern times, a female rider, Liz Hartel, is credited with the emergence of rehabilitative horse riding. Hartel became a paraplegic due to the polio virus. Despite this disability, Liz earned a silver medal in the dressage event of the Helsinki Olympics in 1952. The dressage event drew interest in the rehabilitation potential of horseback riding. History demonstrates that rehabilitation is possible through horseback riding. Through such evidence, it becomes clear that horses have been important since ancient times, providing humans transportation and emotional consolation.

World Trends in HBRT

In 1965, an advisory committee for HBRT began in the United Kingdom with nine members. The committee was extended and reorganized in 1969 with eighty members, and it was renamed the Riding for the Disabled Association (RDA). In 1969, the North American Riding for the Handicapped Association (NARHA) was established and became the basis for the systemic advancement of HBRT. HBRT groups developed independently in each nation and were unified after the establishment of a world association. The Federation Riding for the Disabled International A.I.S.B.L (FRDI) was launched in 1980. This organization allowed international exchange of information about HBRT while advancing each association reciprocally. Simultaneously, the federation was composed of regular members, including 31 nations and 49 groups with associate members of 49 nations and 186 groups. In Korea, one group of regular members and two groups of associate members are enrolled in the federation. The RDA Korea was registered as a regular member in 2001. The RDA-Samsung and RDA-Korea Racing Authority (KRA) were registered as associate members in 2001 and 2007, respectively.

Types of HBRT

Hippotherapy

The prefix *Hippo* means horse in Greek and the suffix *therapy* means treatment. Thus, hippotherapy improves the physical condition of riders by allowing them to respond to the horse's movement. The horse rider can feel pelvic movement during horse riding, movement similar to normal human walking. Thus, the movement of the pelvis provides a signal to the brain mimicking pelvic movement. For a disabled person, this pelvic movement could provide an experience similar to walking. The horse's body temperature is 37.5℃, which is 1℃ higher than the human body's temperature. This 1℃ difference offers comfort to the rider. Another pleasant experience is the communication between the horse and the rider.

Lesson Riding/Therapeutic Riding

Lesson riding focuses on the emotional and spiritual aspects of physical exercise. Literally, therapeutic riding provides treatment through horseback riding. However, this section describes therapeutic riding as lesson riding. Lesson riding is intentionally designed for the content of the program rather than the literal meaning of therapeutic riding. Lesson riding includes the entertainment and pleasure derived from horse riding. Lesson riding may provide psycho-social rehabilitation. Simultaneously, emotional security, improved confidence and advanced physical functions are obtainable effects with lesson riding. These benefits are acquired during horseback riding training. Consequently, disabled individuals who have therapeutic rehabilitation for their entire lives receive amplified rehabilitation effects through diverse activities with live animals.

Outcomes of HBRT

Physical Aspects

HBRT activity strengthens the skeletal muscles, tendons and ligaments. In addition, HBRT activity corrects posture, cures stiffening and spasm in muscles, provides a healthy lung and heart, prevents diseases caused by inappropriate blood circulation, improves bathyesthesia and logopedia effects and provides a training sensor for balance and harmony in body parts. Additionally, HBRT activity supports the avoidance of supervening injuries by cultivating patience and skillfulness and by reducing the need for medications.

Spiritual Aspects

HBRT may enhance desire, confidence, concentration and courage, resulting in the reduction of depression in exhausted patients suffering from long-term hospitalization and medication use. A close relationship between a horse and a human also gives disabled people a feeling of obligation and positive consciousness.

Educational and Social Aspects

A disabled person who has a sense of responsibility towards a horse becomes encouraged to engage in upward social mobility, widening relationships with other members of society and expanding on hobbies. In addition, disabled individuals can gain a new understanding and trust in society by seeing the veracity and purity of horses.

Precedents with HBRT

Once, One case study involves a child who suffered from chronic constipation due to a lack of movement caused by a weakened internal organ. After HBRT, the child was able to consume more food due to improved digestion. HBRT provided the child with better physical development than before. For example, reduced development in the pelvis and bladder muscle had caused unconscious peeing in the middle of the night. This enuresis problem was resolved by HBRT.

As a second example, an autistic child in elementary school had difficulty riding a bicycle without help because of a lack of balance. The child only could ride a bicycle equipped with auxiliary wheels. However, the child learned to ride a bicycle after horseback riding rehabilitation. During the first ride, the child's rigid skeletal muscle was disturbed and the leg stretching caused pain. However, repeated horse riding reduced the rigidity of the skeletal muscle and enhanced the child's leg stretching. As another example, an autistic child suffered from disturbed sleep in the middle of the night, but HBRT provided sound sleep for the child. In another case, mentally disabled children were experiencing severe stress at school. However, they felt extreme happiness while visiting a horseback riding facility or riding a horse. During horseback riding, they were trained to recognize the pace of a horse, which improved their responsive ability to perceive changes in their surroundings. Furthermore, after about three months of training, they showed a noticeable enhancement in their language capabilities. One child had never talked to his father. However, HBRT encouraged the child to talk about horses and allowed him to meet other children. Thus, a positive change in socializing appeared for this child. Consequently, it can be said that horses are ideal companions and therapy animals for children.

Organization of HBRT Training

Several conditions must be met to achieve successful therapy with HBRT, including a strong harmony between the horse, HBRT instructor and patient. Meanwhile, the patient must be willing and excited to attend HBRT. Ultimately, HBRT deals with the whole harmony and balance of humans; it does not focus on treatment of partial problems. The relationship between all components must be pure and trusting. The stronger the trust between the horse, instructor and patient, the faster harmony and balance can grow between them. As a result, partial problems in the patient can improve through holistic harmonization. HBRT requires at least three people, including the instructor, leader and side walker.

LITERATURE REVIEW

1. EQUINE CONFORMATION

1.1 Objective of Conformation

The conformation of the modern horse has arisen as a result of both natural and human-induced selection for various purposes (Saastamoinen and Barrey, 2000). Gait evaluation during free movement may allow better distinction between genetically favorable and unfavorable individuals than gait evaluation under rider, particularly with regard to trot (Becker et al., 2011).

The use of instrumental techniques for conformation and biomechanical evaluation can provide more objective and quantitative data to assess locomotion. Whether horses are used for sport, work, leisure or as companion animals, the performance and health of the locomotor apparatus is crucial. Different kinds of applied biomechanical methodologies provide objective and quantitative tools to assess locomotion. Such methodologies can benefit the practitioner in performing a lameness work up or pre-purchase examination. They may also assist scientists' evaluation treatments, diagnostic methods, rehabilitation, or convalescence. Breeding organizations may use locomotion patterns for early and objective selection in breeding programmers, and trainers may wish to evaluate training regimes using these techniques (Roepstorff, 2012). Above all, classic horse-riding requires that a horse moves naturally, despite the difficulty of the exercises, and these natural movements only improve when the training is of the highest quality (Podhajsky, 1976). According to the official manual of the Riding for the Disabled Association (RDA), a good, calm, and kind temperament is the first essential for horses interacting with disabled people (The Riding for the Disabled Association, 1990).

There are a few reports about the relationship between equine ability for dressage and conformation. Holmström et al. (1990) showed that elite dressage horses and show jumpers had larger hock angles and more sloping scapulas than other Swedish warmblood horses. Holmström and Philipson showed that horses with high scores for jumping had a narrow front cannon at the mid-point, a short hind phalanx, and large angles of the stifle and hock joints (Holmström and Philipson, 1993).

1.2 Conformation of Horse Species and Method

Conformation is traditionally evaluated subjectively, where the conformation of each horse is compared to an ideal. A linear assessment trait evaluation system is used in some horse populations for conformation evaluation (Koenen et al., 1995; Mawdsley et al., 1996). In recent years, methods have been developed that allow objective quantification of conformation. Following such methods, the structural arrangement of body segments (the segments lengths and proportions, angles and deviations) are measured with the aim of producing reliable data that can be related to performance and soundness for use in practical breeding work. Experts have applied both direct measurements on the horse (Mawdsley et al., 1996; Ragnarsson, 1979) and indirect measurements using photograph (photogrammetric methods) (Barrey et al., 2002; Holmström et al., 1990; Langlois et al., 1978) and images provided by video records (Crevier-Denoix et al., 2006; Weller et al., 2006). Most of these methods depend on the positioning of the horse in a predefined way and placement of markers on anatomically interesting landmarks. Notably, the stance of the horse and placement of markers are the two main sources of error when measurements are taken live and in photos (Magnusson and Thafvelin, 1990; Weller et al., 2006).

1.3 Role of Conformation

Conformation of horses has traditionally been an important part of the breeding goal, where selection mainly has been based on anecdotal practical experience (Beeman, 1973; Wrangel, 1887). It was early suggested that the proportions and relative angles between parts of the equine conformation would be important for the usability of the horse. Also, it was suggested that a horse that was rectangular, thus slightly longer from chest to tail than the withers height, would be preferred.

1.4 The SWB(Swedish Warmblood Association) of conformation

In a study of the SWB (n=1815) a high total sum of the five overall conformation scores have represented horses with a significantly lower risk of future early culling (Wallin *et al.*, 2001). Further, long necks have been found associated to high scores for movements during the conformation examination, where high scores for movements in turn were favourably associated to the overall orthopaedic health (n=195) (Holmström and Philipsson, 1993). Also, a significant relationship between a steep slope of the shoulder and impaired orthopaedic health 14
status was found. In another study of SWBs (n=636), slightly sloping shoulders were more common in elite dressage and jumping horses, compared to general riding horses that had straighter shoulders (Holmström *et al.*, 1990). A long neck, a long slightly sloping shoulder and a sloping long croup have also been found significantly correlated to good dressage performance in the KWPN (Koenen *et al.*, 1995). In the same study well developed muscles of the neck and haunches, and a slightly sloping croup were significantly correlated to show jumping performance. No large differences in favourable conformation between the disciplines were found.

1.5 The SWB(Swedish Warmblood Association) of size measures

Withers height and cannon bone circumference just below carpus are measured and considered during the conformation evaluation. In the KWPN population, the tallest horses were found to be at highest risk of culling from basic jumping and dressage, when dividing horses into quartiles for withers height, but with no negative effects for the smallest horses (Ducro et al., 2009). In Standardbred trotters intermediate sized horses have been found most favourable for orthopaedic health (Magnusson and Thafvelin, 1985).

2. GAIT CHARACTERISTICS OF EQUINE

2.1 Gait

Terrestrial animals adopt a wide range of gaits when moving over ground; for example, they walk to move at slow speeds and run, trot, gallop and/or hop for faster locomotion. This broad spectrum of gaits raises the question of the factors that govern gait selection. Several explanations for gait transitions have been proposed based on kinematic factors (Hreljac, 1995), muscle activation (Prilutsky and Gregor, 2001), mechanical restrictions (Alexander, 1984), dynamic-systems theory (Diedrich and Warren, 1995; Raynor et al., 2002), and mechanical loading, such as musculoskeletal force (Farley and Taylor, 1991) and bone strain (Biewener and Taylor, 1986).

Margaria (1938), who investigated the walk–run transition in humans, was among the first to report a metabolic advantage of gait selection by showing that above 2 m s–1, approximately the speed where humans change gait, walking is metabolically more expensive than running; below this speed, the converse is true. A similar metabolic advantage has been observed in horses as they select between walking, trotting and galloping gaits (Hoyt and Taylor 1981; Wickler et al., 2003). Hopping animals, such as the kangaroo, also seem to select metabolically optimal gaits, the transition in this case being from pentapedal walking to bipedal hopping (Dawson and Taylor, 1973). These findings have led to the view that gait selection is a trait that has been selected to minimize the metabolic costs of locomotion.

The relationship between the metabolic cost of locomotion and gait selection has been explained largely on the basis of the kinetics of locomotion (Cavagna et al., 1977; Minetti, 2000). During walking, the body behaves as an 'inverted pendulum', with the body's center of mass (COM) vaulting over a stiff supporting leg. The gravitational potential energy and kinetic energy of the COM fluctuate close to 180° out of phase and, at moderate walking speeds, attain nearly equal magnitude. The inverted-pendulum mechanism thereby results in an energy exchange between gravitational potential energy and kinetic energy and, consequently, saves a substantial amount of the mechanical energy required to move the body's COM, up to 70% in humans (Cavagna et al., 1977). However, as walking speed increases, the amount of energy exchange between gravitational potential energy and kinetic energy is reduced, and at fast walking speeds, considerably more mechanical work is probably done via active muscle contraction, thus contributing to the steep increase in metabolic cost (Kram et al., 1997). It is thought that humans and horses avoid this problem by adopting a run, a bouncing gait that takes advantage of a second energy-saving mechanism, namely elasticenergy storage and release. During running, there is little energy saved by pendular-energy conservation because the gravitational potential energy and kinetic energy of the COM fluctuate in phase. Instead, the spring-like properties of muscles and tendons in the stance phase of running result in an exchange between the kinetic energy of the COM and the elastic energy stored in these tissues (Cavagna et al., 1964, 1977; Ker et al., 1987; Roberts et al., 1997). At fast speeds, when the inverted-pendulum mechanism of walking is impaired, this bouncing gait provides a highly effective means of reducing the metabolic cost of locomotion.

In horses, gait is defined by the cyclic pattern of limb movements that occur during each stride. For example, the regular, four-beat and lateral sequence of the walk is differentiated from the irregular, four-beat and footfall sequence of the gallop. Breed differences in style and image of joint motion contribute to gait motion (Imus, 1995). Locomotor research has described the kinematics of the walk (Deuel and Park, 1990; Clayton, 1995; Hodson et al., 2000; 2001), trot (Drevemo et al., 1980; Deuel and Park, 1990; Clayton, 1994a; Holmstrom et al., 1995), pace (Crawford and Leach, 1984; Wilson et al., 1988), canter (Deuel and Park, 1990; Clayton, 1994b), and gallop (Hellander et al.,1983; Deuel and Lawrence, 1986; Leach et al., 1987). Only a few of these gaits have been analyzed kinematically, including the trot (Clayton and Bradbury, 1995; Graselli, 1991; Zips et al., 2001). Consequently, the gait definitions provided by the breed genomical assocation are often unclear and may be incorrect. Some of the gaits are performed by various gaited breeds, sexes, ages and conformations, such as the gaited mountain breeds and the Gaited American Bashkir Curly Horse.

2.2 Gait Terminology

A great diversity exists in equine locomotion patterns because quadrupedal locomotion allows many combinations of inter-limb coordination. Furthermore, horse breeds have been genetically selected and specialized for different uses, including draught, riding, meat production, pacing, trotting and galloping races, show jumping, dressage, and endurance. A large range of gaits can be observed and classified according to their linear and temporal characteristics: walk, tölt, pace, passage, trot, canter, rotary gallop and transverse gallop (Hildebrand, 1965; Clayton, 1997). As a result, efforts have been made to create a standard terminology for describing equine locomotion (Leach et al., 1984; Clayton, 1989; Leach, 1993).

For the clarity of this paper, the following terms are defined and expanded upon: gait, trot, and stride. *Gait* can be defined as a complex and strictly coordinated rhythmic and automatic movement of the limbs and the animal's entire body resulting in the production of progressive movements. Two types of gait can be distinguished by the symmetry or asymmetry of the limb movement sequence with respect to time and the horse's median plane: symmetric gaits (walk, tölt, pace, trot) and asymmetric gaits (canter, gallop). Within each gait, there exist continuous variations. Among the normal variations of the *trot*, the speed of the gait increases from collected to extended trot. Passage and piaffe are two dressage exercises derived from the collected trot. In racing trotters, abnormal trot irregularities can occur during a race: at the aubin, the forelimbs gallop and the hind limbs trot; at the traquenard, the forelimbs trot and the hind limbs gallop. The *stride* is defined as a full cycle of limb motion. Since the pattern is repeated, the beginning of the stride can be at any point in the pattern, and the end of that stride occurs at the same place in the beginning of the next pattern. A complete limb cycle includes a stance phase when the limb is in contact with the ground and swing phase when the limb is not in contact with the ground. During the suspension phase at trot, pace, canter or gallop, there is no hoof contact with the ground. The duration of the stride is equal to the sum of the stance and swing phase durations. The stride frequency corresponds to the number of strides performed per unit of time. The stride frequency is equal to the inverse of stride duration and is usually expressed in stride/s or in hertz (Hz). The stride length corresponds to the distance between two successive hoof placements of the same limb.

2.2 Gait Characteristics

Gait can be defined as having specific interlimbs, trunk angles, neck angles and forelimb angle coordination patterns that are used within a limited variation of speeds, gaits, and character. They may show discontinuous changes in one or more defining variables during a transition (Hildebrand, 1965; Abourachid, 2003; Robilliard et al., 2007).

Each species performs a repertoire of gaits with transitions between speed, gait, and character, usually performed when increasing or decreasing speed. Horses have become a paradigm in the gait literature because they exemplify the use of three main gaits: walk, trot, seating trot, and walk trot. There exists a wealth of experimental studies analyzing the kinematics and dynamics of equine gait patterns (Buchner et al., 1994; Minetti et al., 1999; Clayton, 1994a; 1994b; 1995; Dutto et al., 2004).

Gait patterns are influenced by the age of the horse, but little is known about gait development. Some studies have investigated the stride characteristics of foals and analyzed the relationship between the conformation and stride variables in foals aged 6–8 months. Speed increases were obtained by a longer stride length in heavier foals and a higher stride frequency in taller foals (Leach and Cymbaluk, 1986). The elbow, carpal and fetlock joint angle flexions were the most significant differences between the foals (Back et al., 1993). The stride and stance duration increased with age, but the swing duration and pro-retraction angle remained consistent. The joint angle patterns recorded at 4 and 26 months were nearly similar. The strong correlations between some kinematic parameters measured in foals and adults make their measurement possible in young horses in order to predict the gait quality of adult horses (Back et al., 1994).

In racehorses, the influence of training has been investigated in standardbreds and thoroughbreds. After 3 years of training, the following changes in the trotting strides were observed: the stride length, the stride duration and swing phase increased (Drevemo et al., 1980). In thoroughbred racing, a stride duration and stride length increase was found (Leach and Springings, 1987). After 8 weeks of a high intensity training regimen on a treadmill, the stance phase duration of the thoroughbred gallop stride was reduced by 8–20% (Corley and Goodship, 1994).

To increase velocity, the horse can switch its gait from walk to trot and from trot to canter and then extend the canter to gallop. Each gait can also be extended by changing the spatial and temporal characteristics of its strides. It appears that each horse has a preferred speed for the trot to gallop transition, and this particular speed is related to the optimal metabolic cost of running (Hoyt and Taylor, 1981).

In thoroughbred racehorses, the fatigue effect on stride characteristics increases the overlap time between the lead hind limb and the non-lead forelimb, the stride duration and the suspension phase duration (Leach and Springings, 1987). The compliance of the track surface also can influence the stride parameters when the horse is trotting or galloping at high speed. During the gallop, the stride duration tends to be reduced on a harder track surface (Fredricson et al., 1983). There is a slight increase in the stride duration on wood-fiber tracks in comparison with a turf track at the same speed. When a rider stimulates the horse with a stick, researchers observed a reduction in the stride length and an increase in the stride frequency corresponding to a reduction of the forelimb stance phase duration; however, the velocity was not significantly influenced (Deuel and Lawrence, 1987).

2.3 Biological Gait

Gait can be defined as the ultimate mechanical expression of exercise activity. In order to perform an exercise activity, the horse requires a synergy between several systems that are functionally linked and regulated by the nervous system. The cardiovascular and respiratory systems provide nutrients and oxygen to the muscles which then transform biochemical energy into mechanical work during muscle contraction. Biochemically, gait involves moving the entire body in rhythmic and automatic patterns that define the various flot. The athletic horse often suffers from injuries in its gait apparatus caused by nutrition, training, shoeing, breeding, tracks, weather, limb conformation and genetics. In thoroughbred racehorses, about 53–68% of cases are due to lameness (Jeffcott et al., 1982; Rossdale et al., 1985).

Some relationships have been established between stride parameters and other physiological variables. During the canter and gallop, the respiratory and limb cycles are synchronized. The inspiration starts from the beginning of the suspension phase and ends at the beginning of the non-lead forelimb stance phase. Expiration then occurs during the stance phase of the non-lead and lead forelimbs (Attenburrow, 1982). Expiration is facilitated by the compression of the rib cage during the weight bearing of the forelimbs. This functional coupling might be a limiting factor for ventilation at maximal exercise intensity. During the walk, trot and pace, there is not a consistent coupling of the locomotion and respiratory cycle. At the trot, the ratio between locomotion and respiratory frequency ranges from 1 to 3 with respect to the speed, duration of exercise and breed (Hörnicke et al., 1987; Art et al., 1990). The same type of low coupling mechanism was observed at a pace where the ratio between the stride and respiratory frequency was 1 to 1.5 (Evans et al., 1994).

Persson et al. (1991) studied the relationship between stride parameters at high speed and muscle fiber composition in standardbreds. The stride length and frequency were extrapolated at a speed equivalent to a heart rate of 200bpm (V200) or V=9m/s. The stride length was positively correlated with the percentages of type I fiber (aerobic slow-twitch fiber) and type IIA fiber (aero-anaerobic fast-twitch fiber), and negatively correlated with the percentages of type IIB (anaerobic fast twitch fiber). The stride frequency was only positively correlated with the percentage of type IIA fibers. However, in another study, the opposite result was found: there was a negative correlation between the stance duration of young trotters and the percentage of type IIB fibers (Roneus et al., 1995). For race trotters, the force–velocity relationship for skeletal muscles implied in limb protraction and retraction might be an important limiting factor of the maximal stride frequency (Leach, 1987). In Andalusian horses, there was no significant correlation between the stance duration and the fiber type percentages. However, the diameter of the fibers was negatively correlated with the stance duration (Rivero and Clayton, 1996). The propulsive force during the stance phase might be higher with larger fibers, especially type I.

During exercise tests, the blood lactate concentrations and heart rate at high speed seem to be more highly correlated with the stride length than to the stride frequency on the treadmill (Persson et al., 1991; Valette et al., 1992). This finding confirms that high speeds eliciting a high cardiac and metabolic response are explained primarily by increased stride length. Furthermore, the velocity related to changes in stride frequency is not linear, and consequently, decreases the correlation coefficient. In ponies tested on the track, the stride frequency was more highly correlated to the blood lactate and heart rate response than to the stride length probably due to the pony's narrow range (Valette et al., 1990).

INTRODUCTION

Horses have been used primarily for riding and racing since domestication around 3500 B.C.E. (Weatherby, 1791). Since the 18^{th} century, the thoroughbred has been a domesticated breed of horse specifically bred for speed, endurance, and strength. The extreme selection for these traits has resulted in a highly adapted athletic horse (Poole, 2004) with very high aero bic capacity (Young et al., 2002), and high skeletal muscle mass (Kayar et al., 1989), comprising over 55% of the total body mass (Gunn *et al.*, 1987).

The oscillation of the rider on Hokkaido native horses with withers heights of 129 ± 2.3 cm was characterized by a higher frequency and smaller amplitude than thoroughbred horses with withers heights of 159 ± 6.1 cm (Matsuura et al., 2003). The kinematic trot characteristics of three different breeds of horses—Andalusian, Arabian, and Anglo-Arabian—showed that the most outstanding feature was the greater forelimb flexion recorded in Andalusian than in the other breeds, which was consistent with the elevated movements in this breed (Cano et al., 2001). Compared to Andalusian horses, the German horses' (e.g., Hanoverians, Oldenburgers, and Westhalians) withers height, back length, fore-and hind-limb length were longer and the angle of each joint was larger. The German horses have gait characteristics that are more adapted for dressage competition, while Andalusian horses are more suited for farm work and old academic dressage (Barrey et al., 2002). The differences in equine oscillation among horse breeds may originate from differences in equine conformation (Johnston et al., 2002). However, minimal research has been conducted on the relationship between equine oscillation and conformation. A few studies, nonetheless, have considered the relationship between equine ability for dressage and conformation. One study showed that elite dressage horses and show jumpers had larger hock angles and more sloping scapulas than other Swedish warmblood horses (Holmstrom et al., 1990). Horses with high jumping scores had a narrow front cannon at the mid-point, short hind phalanx, and large angles in the stifle and hock joints (Holmstrom et al., 1993). Effects of health and conformation traits have also been studied on the basis of different measures of performance (Holmström et al., 1990). studied differences in conformation traits between leisure riding horses and elite horses, which were considered most durable. Slightly sloping shoulders and larger hock angles were more often found in elite dressage and jumping horses, compared with leisure riding horses (n = 61 elite vs 295 leisure horses). In Dutch Warmbloods, a long neck and long, slightly sloping shoulders and croup (the topline of the hindquarters) were also correlated with better performance results in dressage (Koene EPC et al., 1995).

A survey of horse temperament for therapeutic riding has been published by Anderson et al. (1999). If a horse's temperament is suitable, it is then important to consider a wide or narrow conformation, short or long stride, and much or little back movement as selection criteria (RDA, 1990). Therefore, RDA instructors are responsible for allocating suitable horses to the riders. The instructor selects a horse from their experience by considering the type of rider and the objectives of the lesson. However, no scientific grounds are available to help instructors select horses.

The influence of equine conformation on the rider's oscillation needs to be understood to aid in the selection of horses for therapeutic riding. The relationship between equine conformation and the oscillation that the horse transmits to the rider requires further investigation in order to evaluate a horse for this purpose. In order to select the horse in an actual situation therapeutic riding situation, equine conformation should be especially easy to measure. Therefore, the withers height and the trunk width were used to estimate equine conformation. This study aimed to determine the influence of equine conformation on rider oscillation and to use the relationship between these factors to evaluate horses for therapeutic riding according to RDA standards.

The Jeju Special Self-governing Province is the most popular place in Korea representing the horse industry. The natural environment of Jeju, such as the volcanic rock on the grounds, provides optimal conditions for horse breeding while allowing a clean environment for the horses. In addition, efforts and policies to preserve the pure bloodline of original Jeju horses have lead Jeju to be a well-known province for horses and horseracing.

Despite the advantages of horse breeding and in contrast to other livestock animals, such as cattle, pigs and poultry, horses have received less attention; the importance of the horse industry has been underestimated. However, increased awareness of recreational activities has triggered a renewed interest in horses with many attempts to use horses in the leisure sector.

The most imported horse in Korea is the race horse, which has a high withers height. In contrast to imported horses, the Jeju horse has a unique body type with a low withers height. This trait has possibly become a merit in horseback riding for inexperienced tourists, elderly people and children. Furthermore, Jeju horses can be used in therapeutic rehabilitation programs for the mentally and physically disabled. In fact, there are several studies on the therapeutic influences of horses, and they appear to be an important component in the rehabilitation of disabled individuals.

Strict guidelines are required to employ horses for therapeutic rehabilitation. These guidelines include safety and maximization of therapeutic influences. However, such efforts have been hampered by lack of knowledge about the Jeju horse in terms of body type characteristics, such as shape, height, gait trait, and usefulness in rehabilitation.

Until now, traditional Jeju horses, retired race horses, and horses employed without any selective process have commonly been used for leisure riding. Indeed, standards for the selection of horseback riding in Jeju are deficient. Thus, establishing standards to select optimal horses for horseback riding may be the basis for an agreement regarding the objective selection of riding horses. Consequently, standards can be employed for designing horseback riding programs with multiple purposes. For example, classified qualification of horses should be optimized according to the rider's experiences and physical and mental condition in order to create a successful horseback riding program.

Therefore, the present study intends to classify the crossbred Jeju horse by analyzing the traits of the horses according to body shape. Furthermore, the effectiveness of therapeutic rehabilitation and the values of classification are assessed based on the classified horse group in order to qualify the horse as a riding horse. We anticipate that the study data will create an informative platform for further selection of the crossbred Jeju horse.

We conducted an analysis encompassing the classification of body shape and characterization of gait trait in order to establish subjective standards for the Jeju horse. More importantly, the Jeju horses were randomly selected and their bodies was measured for ten criteria: length, chest width, height at withers, height at croup, head length, chest girth, barrel girth, croup length, forearm length and hind cannon length. The horses to be tested were selected and classified for further analysis based on the data. Subsequently, the selected horses were tested and graded according to their gait traits. The tests considered two aspects: three strides and the intensity of oscillation during the strides. In the analysis of stride, researchers observed the pre-step, post-step, length of stride, duration of stride, current cycle and since cycle. The oscillation was evaluated with a 3-D accelerating measurement method along with the frequency of rebound. Moreover, the selected horses' ability for therapeutic rehabilitation was estimated according to the standard manual from the rehabilitation horseback riding association (RHRA), created by qualified riders who are instructors for HBRT. All tests including walking and trotting trials, accomplished with five repetitions, the results of which were scored.

We expect that the study results will be employed in the selection of crossbred

Jeju horses, which is a suitable horse for HBRT. Standardization in the classification of the horse could offer formal guidelines in choosing appropriate horses according to the rider's mental and physical disabilities. Such standardization may secure consistency and safety exercises for therapeutic rehabilitation thus allowing a successful HBRT program to be prepared and distributed through affirmative agreement.

The initial efforts of the present study have been documented and may promote policies that include the development of horse species specific to HBRT. This study may also support propagation to farmers who are interested in breeding horses.

The developed guidelines may also be useful for beginner horseback riders. Presently, there is an absence of standards for horseback riding. Thus, beginners ride any type of horse without considering their level. Such individualized instruction, offering optimal horses for horseback riding, may increase interest levels in horses among both non-disabled and disabled individuals who are seeking attractive leisure activities and a readily enjoyable sport. Those who participate in horseback riding may have little to consider in regards to age and disability. Therefore, increased interest in horseback riding may result in the expansion of the horse industry in Korea. Consequently, production of high quality horses for horseback riding and the distribution of these particular horses can be advanced in the near future.

MATERIALS AND METHODS

Classification by Body Shape of the Jeju Crossbred Horses (Jeju Native X Thoroughbred)

A preliminary survey was conducted to collect basic data on the shapes of Jeju horses. The obtained data was used to classify Jeju crossbred horses (Jeju native X thoroughbred). The survey was performed at the Jung-e and Song Dang horse riding club facilities. The collected data is shown in Appendix A.

Analysis of the Body Shape and the Selection of Representative Horses

An analysis of the body shape was carried out based on several criteria, including height at withers, length and chest width. All measurements were recorded with images, and subsequent measurements were conducted with Image J software to assess other inner parts of the horse, calculated by ratio estimation. The measured height at withers, length and chest width were analyzed by the CLUSTER Procedure Single Linkage Cluster Analysis on Analysis System (SAS Institute Inc. 1999). Similarly, using the factor scores of the factors for the body conformation data with the characteristics that bind them as a group One of the statistical methods of cluster analysis and conduct Respectively. Determine the appropriate number of clusters is using dendogram and that, the calculation of the distance cluster is classified using the ward method, each statistical significance was evaluated (Hair et al. 1995).

$$\mathrm{d}(\mathbf{p},\mathbf{q}) = \sqrt{(p_1-q_1)^2+(p_2-q_2)^2+\cdots+(p_n-q_n)^2} = \sqrt{\sum_{i=1}^{n}(p_i-q_i)^2}.$$

Figure 3. Definition of Euclid distance

Table. 3. Eigenvalues of the covariance matrix

Eigenvalue	Difference	Proportion	Cumulative
41.45	17.11	0.63	0.63
24.34		0.37	1.00

Root-Mean-Square total standard deviation = 5.735176

Mean Distance between observations = 10.15487

Gait Trait Analysis of the Jeju Horse

The selected horses by standard type were subjected to gait trait analysis at the Song Dang and Jung-e horse club riding facilities on April 21st and 22nd, 2011. The details in the experiment were assessed by a qualified professional instructor. The grounds at these two facilities have a straight track, 3 m in width and 40 m end to end in distance. White poles and sticks were used on the track to assist in obtaining an objective outcome. The main poles were set on the side from the middle of the track to the end set apart with a 3m distance; the sticks were serially placed 50 cm between the poles. Observations were recorded using a high-speed digital camcorder (60 frames/sec, VX-2000, Sony), which was placed at a distance of 11 m and a height of 1m from the middle of track with a right angle. In addition, two sets of 3-D accelerometers with two sensors were used in the experiment. The 3-D instrument was fixed on the rider's vest and a sensor was equipped on the withers of the horse; the other sensor was fastened on the rider's right side belt.

Identical saddles with stirrups were used during the experiment, thus eliminating variations in the experiment caused by different saddle weights. The experiment measured a 3-D rebound for a three jog trot during walking (1.5 m/sec) and trotting (3.0 m/sec). Two to three preliminary drives were conducted to calibrate the X-axis to a forward direction. A recording of the 3-D data and walking were started simultaneously. The walking was completed once following straight line, and the recorded data was saved. Similarly, two horse walks, two seating trots and two riding trots were conducted. The time to finish each test was estimated at 20-25 minutes. The results from the test were analyzed with Loger Pro 3 software (Vernier, Korea) and data focused on the strength of the rebound.

HBRT Evaluation of the Selected Horses

Depending on the body shape, the classified horses were examined for rehabilitative properties through a riding test with an internationally qualified HBRT instructor. The evaluation was completed using a questionnaire after horseback riding. Each horse ride was repeated five times, and the HBRT criteria were scored. The questionnaire was conducted and scored according to the RHRA standard manual.

RESULTS

Classification of Jeju Crossbred Horses (Jeju Native X Thoroughbred) by Body Shape

Four groups were classified: short body and narrow chest width (SN) was Type 1; short body and wide chest width (SW) was Type 2; tall body and narrow chest width (TN) was Type 3; and tall body and wide chest width (TW) was Type 4. Subsequently, standards for each group were established and used in the selection of representative horses for further analysis. In detail, we assigned 139 cm of body length, 52 cm chest width and 134 cm height for Type 1; 138 cm body length, 57 cm chest width and 129 cm height for Type 2; 146 cm body length, 56 cm chest width and 142 cm height for Type 3; and 146 cm body length, 66 cm chest width and 142 cm height for Type 4 (Tables 3, 4, 5, and 6). Previous resutl from the swedish warmblood riding horses were examined by RHOT : 8,238case (1983- 2005) resut are tall body and wide chest width (TW) from Type 4 shows a similar tendency to be(Table 7).The age and length measurements showed part of the conformation item (Tables 8 and 9). Table 10 shows the withers height (WH), body length (BL) and chest width (CW) in relation to different horse types and breeds. WH, BL and CW significantly differed between the four groups ($P<0.01$ or $P<0.05$).

Table 4. Classification and conformation of the Jeju crossbred horse (Jeju native X thoroughbred) for body Type 1.

(Unit : ㎝)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
4	1	Female	6	140	51	132	45	133	129	65	48	35	35
5	1	Female	10	140	50	136	51	136	130	66	50	36	35
17	1	male	8	143	52	136	53	137	132	61	40	35	34
19	1	Female	9	131	53	134	51	136	129	63	43	33	33
20	1	Female	10	140	55	134	49	132	128	61	43	34	32
40	1	Female	7	143	54	134	57	141	129	64	43	35	36
41	1	male	4	141	54	131	55	132	125	66	37	36	34
51	1	Female	9	135	52	134	47	130	124	61	42	36	33
76	1	Female	5	138	52	138	58	144	137	63	47	38	34
90	1	Female	10	143	51	135	52	142	134	62	43	31	38

※ Note : Short body and narrow chest width (SN) was Type 1. these horses assigned 139 cm of body length, 52 cm chest width and 134 cm height.

Table 5. Classification and conformation of the Jeju crossbred horse (Jeju native X thoroughbred) for body Type 2.

(Unit : ㎝)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
8	2	Female	12	134	52	127	47	132	123	60	45	34	34
10	2	Female	7	147	63	134	42	131	126	68	43	34	34
12	2	Female	14	129	53	129	49	126	123	63	43	31	31
14	2	Female	12	135	59	127	47	116	115	57	35	28	28
26	2	Female	8	140	60	134	49	134	128	63	41	32	31
57	2	Female	14	150	62	134	46	131	123	58	42	33	34
79	2	Female	20	129	51	128	56	130	121	59	44	33	33
80	2	Female	12	147	58	135	51	135	127	64	48	29	32
91	2	Female	8	143	64	125	46	126	120	59	43	31	33
93	2	Female	20	134	54	126	51	138	129	64	46	31	34

※ Note : Short body and wide chest width (SW) was Type 2. these horses assigned 138 cm body length, 57 cm chest width and 129 cm height.

Table 6. Classification and conformation of the Jeju crossbred horse (Jeju native X thoroughbred) for body Type 3.

(Unit : ㎝)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
2	3	Female	6	150	57	144	53	138	134	64	42	38	35
18	3	Female	8	141	57	142	53	141	134	62	43	31	31
24	3	Female	7	140	57	143	51	141	136	67	42	36	35
25	3	Female	7	140	57	143	50	137	132	63	38	34	35
27	3	Female	7	150	56	144	50	141	134	63	41	41	35
37	3	Female	7	155	56	142	53	143	140	70	44	38	40
43	3	Female	7	145	56	141	52	144	136	69	44	33	36
44	3	male	4	147	57	143	50	140	133	62	41	34	42
49	3	Female	9	153	57	141	50	139	132	63	40	36	35
87	3	Female	7	141	56	142	54	142	135	67	43	32	33

※ Note : Tall body and narrow chest width (TN) was Type 3. these horses assigned 146 cm body length, 56 cm chest width and 142 cm height.

Table 7. Classification and conformation of the Jeju crossbred horse (Jeju native X thoroughbred) for body type 4.

(Unit : ㎝)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
1	4	Female	10	147	62	143	52	135	130	67	43	35	37
7	4	Female	10	147	62	143	51	134	129	65	43	34	33
16	4	Female	11	144	67	141	47	131	128	66	42	34	30
22	4	Female	9	144	67	142	54	136	131	68	45	33	33
34	4	Female	7	149	69	143	56	143	136	68	39	33	36
54	4	Female	13	143	67	139	49	133	125	64	44	35	34
58	4	Female	6	149	67	143	46	132	129	64	41	36	35
61	4	Female	18	149	67	143	45	144	136	66	48	36	38
68	4	Female	18	149	69	143	49	137	134	59	42	33	35
89	4	Female	12	143	67	140	54	144	134	66	46	33	35

※ Note : Tall body and wide chest width (TW) was Type 4. these horses assigned 146 cm body length, 66 cm chest width and 142 cm height.

Table 8. Body conformation of Swedish Warmblood riding horses of various categories evaluated between 1983 and 2005.

Variable	No. of horses	Mean ± SD	Estimated difference between noncompeting and competing horses*		*P* value
			Absolute units	SD units	
Conformation					
Type	8,196	7.82 ± 0.59	−0.09	−0.15	< 0.001
Head, neck, and body	8,196	7.73 ± 0.56	−0.03	−0.05	< 0.05
Limb	8,196	7.35 ± 0.66	−0.02	−0.03	NS
Walk at hand	8,196	7.38 ± 0.76	−0.08	−0.11	< 0.001
Trot at hand	8,196	7.11 ± 0.80	−0.13	−0.16	< 0.001
Height at withers (most dorsal aspect of the shoulders between the scapulae [cm])	8,234	164.4 ± 4.37	−0.37	−0.08	< 0.001
Circumference of metacarpus (cm)	8,234	21.3 ± 0.97	−0.39	−0.40	< 0.05

*Determined from general linear models of differences in RHQT scores between horses with and without competition results. *P* values indicate comparison between noncompeting and competing horses.
NS = Not significant.

Mean ± SD scores for health, conformation, gait, and jumping talent variables in Swedish ridin ghorses evaluated by use of an RHQT(Jonsson et al. 2014)

Table 9. Classification and conformation of the Jeju crossbred horse (Jeju native X thoroughbred) for the three groups (Ages 4-10, 11-15 and 16-20).

(Unit : cm)

Variable (Old)	Number	Withes height	Chest width	Body length	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
4~10	62	140.53 ± 4.14	58.00 ± 5.51	147.48 ± 6.51	52.50 ± 4.13	138.35 ± 4.78	132.53 ± 4.51	64.43 ± 2.79	42.57 ± 2.75	34.64 ± 2.38	34.75 ± 2.41
11~15	20	134 ± 5.78	60.63 ± 6.16	139.38 ± 7.69	48.75 ± 2.66	131 ± 7.93	124.75 ± 5.42	62.25 ± 3.49	43.13 ± 3.87	32.13 ± 2.53	32.25 ± 2.43
16~20	12	135 ± 9.27	60.25 ± 9.07	140 ± 10.1	50.25 ± 4.57	137.25 ± 5.74	130 ± 6.68	62 ± 3.56	45 ± 2.58	33.25 ± 2.06	35 ± 2.16
Total	94	139.24 ± 5.11	59.51 ± 6.31	147.10 ± 7.73	51.96 ± 4.21	137.14 ± 5.49	131.29 ± 5.26	65.28 ±8.24	43.41 ± 4.42	34.40 ± 2.62	34.35 ± 2.65

※ Note : Each group measurements showed part of witnes height, chest width, body length, head length, croup height, chest girth, chest depth, croup length, cannon circumference and hind circumference.

Table 10. Classification and conformation of Jeju crossbred horse (Jeju native X thoroughbred) for the three groups (withers height: 121-130, 131-140, and 141-150).

(Unit : cm)

Variable (Withers height)	Number	Body length	Chest width	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
121~130	6	134.00 ± 5.14	55.50 ± 5.01	49.33 ± 3.72	128 ± 7.38	121.83 ± 4.58	60.33 ± 2.66	42.67 ± 3.93	31.33 ± 2.07	32.17 ± 2.32
131~140	45	141.29 ± 5.44	56.93 ± 5.92	49.86 ± 4.05	135.00 ± 4.40	127.93 ± 3.32	63.64 ± 2.59	43.79 ± 3.31	33.71 ± 2.05	34 ± 1.80
141~150	43	146.50 ± 6.08	60 ± 5.68	51.35 ± 3.18	138.95 ± 4.01	133.40 ± 3.07	64.85 ± 2.91	42.40 ± 2.46	35 ± 2.43	35.10 ± 2.75
Total	94	147.10 ± 7.73	59.51 ± 6.31	51.96 ± 4.21	137.14 ± 5.49	131.29 ± 5.26	65.28 ± 8.24	43.41 ± 4.42	34.40 ± 2.62	34.35 ± 2.65

※ Note : Each group measurements showed part of witnes height, chest width, body length, head length, croup height, chest girth, chest depth, croup length, cannon circumference and hind circumference.

Table 11. A comparison of withers height, body length and chest width by body type.

(Unit : cm)

Variable	Withers height	Body length	Chest width
Type1	$134.20^{ab} \pm 2.44$	$139.40^{a} \pm 3.86$	$52.40^{a} \pm 1.58$
Type2	$129.90^{a} \pm 3.90$	$138.80^{a} \pm 7.69$	$57.60^{ab} \pm 4.79$
Type3	$142.50^{b} \pm 1.08$	$146.20^{b} \pm 5.63$	$56.60^{ab} \pm 0.52$
Type4	$142.00^{b} \pm 1.49$	$146.80^{b} \pm 7.36$	$66.40^{b} \pm 2.46$
Significance	*	*	**

Significance Level: *p<0.05: **p<0.01

^{a,b} Means with different superscripts in the same row are significantly different ($p<0.05$)

※ **Note : The withers height (WH), body length (BL) and chest width (CW) in relation to different horse types and breeds. WH, BL and CW significantly differed between the four groups**

In In the walking test, a longer jog trot was observed in Types 1 and 2 with the horseman riding and in Type 2 without the horseman riding. An increased pro-rata duration of the jog trot was observed with an increase of the jog trot length. Meanwhile, extension of the current cycle and the since cycle were also observed after increased jog trot length. The shortest length, duration, current cycle and since cycle of the jog trot were observed in Type 4 in both conditions—with and without the horseman riding. During the sitting trot, the length of the jog trot was long in Types 1 and 2 with the horseman riding and in Type 2 without the horseman riding. The duration, current cycle and since cycle were increased by a pro-rata with an increase in the length of the jog trot. In the experiment, Type 4 had the shortest length, duration, current cycle and since cycle.

A majority of the results in the sitting trot were similar to the riding trot, except in the case of Type 3. The length of the jog trot was the longest in Types 1 and 2 with the horseman riding. The duration, current cycle and since cycle of the jog trot were also increased with a pro rata in the increased length of the jog trot. There was difference in the analysis of Types 3 and 4. We observed that length, duration, current cycle and since cycle of the jog trot decreased. In other words, Type 2 had a short length body, small chest width and height at wither. At the same time, it had a longer length of pre- and post-steps for the length, duration, current cycle and since cycle of the jog trot compared to Type 4. In contrast to Type 2, Type 4 had a relatively long body length, chest width and height at wither.

The evaluation of rebound for the horseman and selected horses were performed by measuring 3-D acceleration during horse riding. Significant data was obtained by ignoring the starting and ending sections of the experiment, eliminating the irrelevant effect of acceleration. Significant data was obtained in five to ten second sectors, and the data was analyzed with Pro logger 3 software programs. Considering 3-D spaces in the experiment, the acceleration data was obtained from the X-axis, and the rebounding value was obtained from the Z-axis while considering the movement of the horseman. In the analysis of the horse rebound, the walking, sitting and riding trots of Type 2 resulted in the fastest acceleration of the X-axis, while the slowest acceleration of the walking, sitting and riding trots were observed in Type 4. However, the frequency rebound in Type 4 was highly ranked.

The rebounding of the horseman was similar to the rebounding of the horse. In Type 2, the walking, sitting and riding trots showed the fastest acceleration on the X-axis. The Type 4 horses showed the slowest acceleration on the X-axis. However, the most frequent rebound was observed in Type 4. According to the results, the study recognizes that the rebounds and accelerations were similar. When we compared Type 2 and Type 4, Type 2 had a shorter body than Type 4. However, the shorter body showed faster acceleration with larger movement during horseback riding.

Table 12. Results of trot type riding compared to each type.

Variable	Type 1		Type 2		Type 3		Type 4	
	Riding	No riding	Riding	No riding	Riding	No riding	Riding	No riding
-Before step(m)	0.57±0.08	0.62±0.06	0.55±0.08	0.67±0.06	0.50±0.05	0.61±0.03	0.55±0.05	0.59±0.05
-Post step(m)	0.57±0.07	0.64±0.05	0.58±0.04	0.66±0.03	0.52±0.06	0.64±0.03	0.54±0.05	0.59±0.04
Length of jog trot(m)	1.15±0.15	1.26±0.10	1.13±0.11	1.33±0.09	1.03±0.11	1.26±0.06	1.10±0.10	1.18±0.09
Maintenance time of jog trot(s)	0.91±0.06	0.97±0.09	0.98±0.10	1.03±0.07	0.89±0.07	0.96±0.10	0.93±0.10	0.93±0.06
- Actual period (%)(s)	0.33±0.03	0.34±0.01	0.34±0.04	0.37±0.02	0.31±0.03	0.35±0.34	0.33±0.32	0.32±0.02
- Pillar period (%)(s)	0.58±0.04	0.62±0.08	0.63±0.08	0.65±0.05	0.57±0.03	0.61±0.08	0.59±0.94	0.61±0.06

※ Note : A longer jog trot was observed in Types 1 and 2 with the horseman riding and in Type 2 without the horseman riding. The shortest length, duration, current cycle and since cycle of the jog trot were observed in Type 4 in both conditions with and without the horseman riding.

Table 13. Results of sitting trot riding compared to each type.

Variable	Type 1		Type 2		Type 3		Type 4	
	Riding	No riding	Riding	No riding	Riding	No riding	Riding	No riding
-Before step(m)	0.69±0.09	0.81±0.08	0.70±0.09	0.81±0.08	0.64±0.08	0.75±0.09	0.61±0.07	0.73±0.06
-Post step(m)	0.67±0.10	0.80±0.05	0.71±0.08	0.82±0.06	0.65±0.07	0.77±0.07	0.61±0.06	0.72±0.07
Length of jog trot(m)	1.76±0.15	1.84±0.08	1.79±0.12	1.90±0.15	1.70±0.13	1.81±0.09	1.65±0.12	1.73±0.12
Maintenance time of jog trot(s)	0.62±0.05	0.62±0.04	0.66±0.05	0.66±0.03	0.63±0.06	0.60±0.04	0.61±0.03	0.60±0.04
- Actual period (%)(s)	0.28±0.03	0.33±0.16	0.32±0.28	0.36±0.02	0.29±0.03	0.33±0.02	0.28±0.02	0.31±0.03
- Pillar period (%)(s)	0.33±0.04	0.29±0.31	0.34±0.46	0.30±0.02	0.33±0.04	0.27±0.02	0.32±0.02	0.28±0.03

※ Note : A sitting trot was observed in Types 1 and 2 with the horseman riding. The shortest length, duration, current cycle and since cycle of the jog trot were observed in Type 4 in both conditions with and without the horseman riding.

Table 14. Results of trot type riding compared to each type.

Variable	Type 1	Type 2	Type 3	Type 4
	Riding	Riding	Riding	Riding
-Before step(m)	0.82±0.08	0.82±0.11	0.75±0.09	0.75±0.07
-Post step(m)	0.78±0.11	0.82±0.09	0.75±0.10	0.74±0.06
Length of jog trot(m)	1.88±0.18	2.07±0.52	1.84±0.12	1.81±0.11
Maintenance time of jog trot(s)	0.58±0.04	0.63±0.04	0.59±0.03	0.56±0.04
- Actual period (%)(s)	0.31±0.02	0.33±0.03	0.32±0.02	0.29±0.02
- Pillar period (%)(s)	0.27±0.03	0.29±0.04	0.26±0.02	0.26±0.02

※ Note : A majority of the results in the sitting trot were similar to the riding trot, except in the case of Type 3.

Table 15. Results of the horse rebound with 3-D accelerometer measurements for each type.

Variable	Max			Minimum			Average			Number of rebound
	X	Y	Z	X	Y	Z	X	Y	Z	
T1 jog trot1	5.61± 2.02	3.48± 1.54	13.69± 1.14	-4.19± 1.17	-4.13± 1.16	5.66± 1.27	2.46 ±1.1	-0.45 ±0.54	9.45 ±0.28	10.3
T1 jog trot2	5.21± 1.95	3.58± 1.03	13.35± 0.86	-4.51± 2.42	-4.04± 2.01	5.52± 1.32	1.29 ±1.24	-0.25 ±0.64	9.45 ±0.32	9.9
T1 seating trot1	16.26± 5.87	8.25± 2.52	23.08± 6.7	-12.45± 3.16	-9.93± 4.17	-2.05± 2.88	1.02 ±1.01	-0.35 ±0.52	9.43 ±0.19	16.2
T1 seating trot2	16.25± 6.83	10± 5.46	24.97± 9.58	-15.59± 3.63	-9.72± 3.59	-4.64± 5.86	1.07 ±1.06	-0.32 ±0.59	9.38 ±0.25	15.8
T1 riding trot1	17.65± 4.48	8.55± 1.96	27.1± 8.9	-22.24± 2.86	-9.09± 2.09	-6.54± 3.53	1.05 ±1.1	-0.32 ±0.58	9.32 ±0.32	17.1
T1 riding trot2	17.17± 2.87	8.25± 2.44	24.57± 7.46	-24.1± 4.02	-10.27± 2.07	-6.06± 3.19	0.77 ±0.98	-0.24 ±0.66	9.22 ±0.17	17.0
T2 jog trot1	8.62± 2.19	3.71± 1.46	13.58± 1.14	-2.23± 1.11	-3.98± 1.13	5.72± 1.27	3.14 ±1.15	-0.30 ±0.53	9.60 ±0.28	10.9
T2 jog trot2	8.19± 1.97	4.16± 1.18	14.21± 0.86	-2.97± 2.42	-5.14± 2.04	5.7± 1.35	2.98 ±1.26	-0.41 ±0.58	9.56 ±0.32	10.9
T2 seating trot1	20.18± 5.94	10.14± 2.34	23.6± 6.66	-11.26± 3.36	-13.32± 4.18	-9.61± 2.88	3.02 ±1.08	-0.39 ±0.49	9.43 ±0.18	15.0
T2 seating trot2	18.09± 6.82	8.6± 5.47	22.39± 9.14	-11.11± 3.4	-10.93± 3.57	-6.18± 2.45	2.89 ±1.12	-0.44 ±0.54	9.35 ±0.25	14.6
T2 riding trot1	20.15± 3.97	8.56± 2.02	27.95± 8.72	-15.85± 3.71	-10.62± 1.8	-6.72± 2.21	2.99 ±1.14	-0.44 ±0.55	9.34 ±0.33	16.0
T2 riding trot2	18.73± 2.9	9.53± 2.45	26.17± 7.02	-18.73± 5.32	-11.68± 1.78	-9.59± 2.27	2.52 ±1.04	-0.48 ±0.59	9.31 ±0.2	15.6
T3 jog trot1	5.82± 2.29	2.91± 1.55	13.91± 1.37	-4.36± 1.17	-4.06± 1.27	5.47± 1.39	0.82 ±1.13	-0.56 ±0.54	9.33 ±0.27	10.1
T3 jog trot2	6.17± 1.96	3.36± 1.19	13.47± 0.88	-5.57± 2.4	-4.67± 1.95	5.43± 1.28	0.50 ±1.18	-0.58 ±0.72	9.29 ±0.35	8.8
T3 seating trot1	16.42± 6.26	6.76± 2.68	22.58± 6.42	-12.45± 3.56	-10.43± 3.94	-2.83± 2.16	0.52 ±1.04	-0.56 ±0.59	9.20 ±0.23	15.1
T3 seating trot2	15.47± 6.58	9.51± 5.62	23.02± 9.15	-14.97± 4.07	-10.19± 4.19	-5.57± 4.33	0.16 ±1.04	-0.44 ±0.64	9.19 ±0.32	15.2
T3 riding trot1	18.13± 3.97	8.81± 2.18	23.93± 8.88	-19.72± 4.5	-10.56± 1.48	-7.62± 1.84	0.24 ±1.07	-0.50 ±0.63	9.06 ±0.36	17.0
T3 riding trot2	16.93± 2.99	9.66± 2.17	27.45± 7.03	-21.09± 5.99	-11.55± 1.81	-7.1± 2.2	-0.18 ±1	-0.48 ±0.65	9.05 ±0.26	16.6
T4 jog trot1	6.5± 2.29	3.01± 1.55	14.2± 1.37	-2.77± 1.17	-4.45± 1.2	5.37± 1.39	0.47 ±1.1	-0.22 ±0.45	9.58 ±0.26	12.1
T4 jog trot2	5.76± 1.84	3.12± 1.25	14.14± 0.91	-3.97± 1.48	-3.63± 1.25	5.43± 1.26	0.45 ±1.11	-0.13 ±0.66	9.56 ±0.35	12.2
T4 seating trot1	12.46± 5.81	7.05± 2.45	21.14± 6.42	-11.94± 3.38	-8.56± 3.67	-3.33± 2.02	0.19 ±1.01	-0.09 ±0.57	9.52 ±0.22	17.2
T4 seating trot2	11.6± 5.83	7.66± 5.48	21.89± 9.2	-12.3± 4.2	-7.57± 4.21	-2.31± 4.24	0.03 ±0.97	-0.10 ±0.57	9.44 ±0.3	17.6
T4 riding trot1	16.97± 3.87	7.13± 2.2	22.99± 8.69	-19.23± 5.03	-9.54± 1.53	-6.38± 1.61	0.01 ±1.03	-0.16 ±0.57	9.28 ±0.33	18.1
T4 riding trot2	15.18± 3.32	8.21± 1.94	22.43± 6.82	-20.15± 5.93	-9.29± 1.82	-6.25± 3.28	-0.11 ±0.96	-0.23 ±0.59	9.34 ±0.33	18.1

※ Note : In the analysis of the horse rebound, the walking, sitting and riding trots of Type 2 resulted in the fastest acceleration of the X-axis, while the slowest acceleration of the walking, sitting and riding trots were observed in Type 4. However, the frequency rebound in Type 4 was highly ranked.

Table 16. Results of the rider rebound with 3-D accelerometer measurements for each type.

Variable	Max			Minimum			Average			Number of rebound
	X	Y	Z	X	Y	Z	X	Y	Z	
T1 jog trot1	4.63±1.57	1.41±0.77	14.69±2.07	-2.78±1.62	-2.84±0.82	5.32±1.42	1.25±0.44	-0.71±0.42	9.52±0.2	11.0
T1 jog trot2	4.95±1.12	1.4±0.87	14.65±1.83	-2.87±2.09	-2.91±0.63	5.2±1.6	0.86±0.63	-0.78±0.54	9.5±0.22	10.3
T1 seating trot1	12.17±2.56	4.19±0.98	33.27±5.94	-8.79±2.91	-7.45±2.72	-1.46±0.97	0.97±0.71	-0.85±0.43	9.46±0.2	15.4
T1 seating trot2	11.64±2.91	4.23±0.8	32.19±5.6	-8.47±2.29	-7.03±3.14	-1.54±1.17	0.66±0.51	-0.8±0.65	9.44±0.27	16.6
T1 riding trot1	11.34±3.17	3.6±2.01	30.94±3.98	-8.53±3.95	-4.92±1.18	-0.2±0.84	0.33±1.49	-0.56±0.65	9.43±0.5	9.0
T1 riding trot2	10.4±2.23	3.52±1.53	33.08±5.04	-7.91±0.75	-5.23±0.96	0.08±0.86	0.41±0.63	-0.8±0.57	9.56±0.19	9.0
T2 jog trot1	4.3±1.57	1.51±0.92	13.15±2.1	-2.15±1.63	-2.97±0.83	6.35±1.43	1.09±0.63	-0.78±0.43	9.47±0.2	9.6
T2 jog trot2	4.07±1.18	1.5±1.16	13.21±1.89	-1.74±2.28	-3.12±0.67	6±1.64	0.95±0.92	-0.87±0.54	9.5±0.21	9.4
T2 seating trot1	11.96±2.51	3.91±0.97	32±6	-7.78±2.97	-6.28±2.56	-1.36±0.95	0.95±0.71	-1.01±0.4	9.46±0.21	14.9
T2 seating trot2	12±2.78	4.1±0.82	32.73±5.6	-7.04±2.28	-5.82±3.16	-1.36±1.15	1±0.53	-0.82±0.67	9.43±0.26	14.6
T2 riding trot1	10.22±3.2	2.37±2.02	28.98±3.16	-6.7±4.07	-4.66±1.02	0.1 ±0.91	0.65±1.5	-1.02±0.64	9.58±0.52	7.9
T2 riding trot2	10.51±2.26	2.78±1.6	30.62±5.11	-5.09±1.37	-5.39±0.92	-0.15±0.82	0.87±0.62	-0.96±0.56	9.56±0.19	7.9
T3 jog trot1	4.5±1.54	1.63±0.92	13.58±2.27	-2.16±1.62	-2.59±1.01	6.16±1.49	1.32±0.68	-0.56±0.5	9.34±0.22	9.6
T3 jog trot2	4.33±1.18	1.32±1.16	12.92±1.94	-1.99±2.37	-2.66±0.55	6.38±1.46	1.01±0.95	-0.72±0.45	9.37±0.2	9.8
T3 seating trot1	13.24±1.62	4.22±1.12	34.3±5.39	-7.21±3.36	-6.47±2.68	-1.28±0.86	1.49±0.8	-0.98±0.37	9.23±0.22	15.9
T3 seating trot2	14.44±2.43	4.34±0.86	34.89±5.17	-8.43±1.84	-6.51±3.18	-1.22±1.14	0.83±0.59	-0.69±0.65	9.25±0.28	15.6
T3 riding trot1	11.76±3.09	4.8±2.06	29.74±3.07	-9.39±4.14	-5.81±1.09	-1.33±0.9	0.76±1.5	-0.77±0.62	9.35±0.51	10.1
T3 riding trot2	11.84±2.28	3.58±0.84	30.26±3.58	-8.99±1.83	-5.43±1.2	-0.43±0.67	0.36±0.65	-0.77±0.58	9.37±0.15	8.5
T4 jog trot1	4.92±1.56	2.34±0.9	15.77±2.34	-3.78±1.53	-3.34±1.03	4.5±1.37	0.41±0.68	-0.56±0.49	9.3±0.19	12.0
T4 jog trot2	3.26±1.18	1.25±1.11	13.57±1.82	-3.41±1.52	-2.6±0.6	5.46±1.42	0.16±0.91	-0.59±0.41	9.43±0.15	11.4
T4 seating trot1	8.15±1.6	2.93±1.06	26.38±5	-6.54±3.22	-4.99±2.51	0.03±0.76	0.22±0.81	-0.76±0.36	9.36±0.17	17.1
T4 seating trot2	8.99±2.1	3.42±0.87	27.78±4.91	-8.15±2.26	-5.95±3	-0.8±1.05	0.12±0.69	-1.01±0.58	9.37±0.23	17.0
T4 riding trot1	8.65±2.98	2.95±2.07	28.25±3.21	-8.71±3.82	-5.59±1.01	-0.35±0.94	-0.14±1.48	-0.82±0.6	9.29±0.47	10.8
T4 riding trot2	8.72±2.18	3.7±0.85	29.04±3.47	-8.13±2.02	-4.7±1.19	0.23±0.66	-0.08±0.57	-0.59±0.51	9.36±0.16	9.9

※ Note : In Type 2, the walking, sitting and riding trots showed the fastest acceleration on the X-axis. The Type 4 horses showed the slowest acceleration on the X-axis. However, the most frequent rebound was observed in Type 4.

The evaluations for rehabilitative results are shown in the above tables. Interpretations for the tables are provided below.

1) The effect on the sense of balance

The walking of Type 4 was excellent and ranked first, while the trotting of Type 4 ranked second. The trotting of Type 4 and walking of Type 2 were equally ranked.

2) The effect on skeletal muscle relaxation

The walking of Type 4 ranked first, while the trotting of Type 4 ranked second. The trotting of Type 1 and walking of Type 2 were considerably scored.

3) The effectiveness of exercise

The walking of Type 4 horses ranked first, while the walking of Type 1 ranked second. The walking of Type 2 and trotting of Type 1 were also good during the exercise.

4) The coordination of muscle exercise

The walking of Type 4 was excellent and ranked first. The walking of Type 1 received a good score followed by the walking of Type 4. The walking of Type 2 and trotting of Type 1 were scored.

5) Quickness

The walking of Type 4 was highly scored and ranked first; the trotting of Type 1 ranked second. The walking of Type 1 and the trotting of Type 4 were considered in the evaluation.

6) The improvement of self-confidence

A high score was assigned to the walking of Type 4, and the second highest score was given to Type 1. Acceptable scores were assigned to the walking of Type 2 and the trotting of Type 4.

7) The effect of deep position riding

The walking of Type 4 ranked first and the walking of Type 1 ranked second. The trotting of Type 1 and the walking of Type 2 were also assessed as good candidates.

8) The control efficiency of tested horses

The walking of Type 4 horses ranked first, and the trotting of Type 4 ranked second. Following the walking of Type 3, the trotting of Type 1 received a good assessment score.

9) The application of horseback riding in the aspect of exercise

The walking of Type 4 was excellent and ranked first; the walking of Type 1 was also good and ranked second in the evaluation of exercise. The trotting of Type 1 and the walking of Type 2 were also selected.

10) The feasibility of changing the posture

The walking of Type 4 and the trotting of Type 1 were highly ranked; the walking of Type 1 and Type 2 were also considered.

11) The horseback prone position

The walking of Type 4 ranked as the best, and the walking of Type 1 ranked second. Good results in the assessment were observed in the trotting of Type 1 and Type 4.

12) Tandem riding with an instructor

The walking and trotting of Type 1 were highly effective and ranked first; the walking of Type 2 was considered acceptable.

13) The effect on monoplegia

The walking of Type 4 was the best and ranked first, and the walking of Type 1 ranked second. The walking of Type 2 and the trotting of Type 1 also showed good results.

14) The effect on hemiplegia

The walking and trotting of Type 4 were highly ranked, and the walking of Type 1 ranked second. In addition, the walking of Type 2 and the trotting of Type 1 received good scores.

15) The effect on paralysis in the lower limbs

The walking and trotting of Type 4 horses showed good results, and the walking of Type 1 ranked second. The walking of Type 2 and the trotting of Type 1 were considered acceptable.

16) The effect on quadriplegia

The walking of Type 4 was excellent, and the walking of Type 1 ranked second. The walking of Type 2 and the trotting of Type 1 also showed good results.

17) The effect on athetoid cerebral palsy

The walking of Type 4 received the best score, and the walking of Type 1 received the second best score. The walking of Type 2 and the trotting of Type 1 also ranked highly.

18) The effect on hypertonic cerebral palsy

The walking and trotting of Type 4 was the best, and the walking of Type 1 ranked second. The walking of Type 2 and the trotting of Type 1 also ranked highly.

19) The effect on hypotonic cerebral palsy

The walking and trotting of Type 4 were regarded as the overall best, and the walking of Type 1 received a good score. The walking of Type 2 and the trotting of Type 1 also received good scores.

20) The effect on ataxia

The walking and trotting of Type 4 were excellent, and the walking of Type 1 was ranked second. The walking of Type 1 and the trotting of Type 2 also received good scores.

21) The effect on autistic children

The walking and trotting of Type 4 ranked first, and the walking of Type 1 ranked second. The walking and trotting of Type 1 also received a good score.

22) The effect on mentally retarded children

The walking and trotting of Type 4 were excellent, and the walking of Type 1 ranked second. The walking and trotting of Type 1 were very acceptable.

23) The effect on horsemen less than 110 mm in height

The walking and trotting of Type 4 received the best score. The walking of Type 1 and Type 3 received the second best scores.

24) The effect on horsemen between 110 and 140 cm in height

The walking and trotting of Type 4 had the best exercise score, and the walking of Type 1 and Type 3 horses had the second best scores.

25) The effect on horsemen more than 110 cm in height

The walking and trotting of the Type 4 were highly ranked, and the walking of Type 1 and Type 3 also received good scores.

Table 17. The average scores of the Jeju crossbred horse rehabilitation evaluation for types 1-4.

Variable	Type1 Jog trot	Type1 Riding trot	Type2 Jog trot	Type2 Riding trot	Type3 Jog trot	Type3 Riding trot	Type4 Jog trot	Type4 Riding trot
Sense of balance	4.04	4.13	4.13	3.46	3.61	3.57	4.56	4.18
Relax the tension of muscle	4.04	4.13	4.13	3.48	3.59	3.56	4.56	4.22
Quantity of motion	4.45	4.31	4.44	3.83	3.75	3.66	4.54	4.18
Coordination of muscle work	4.41	4.22	4.31	3.66	3.77	3.68	4.58	4.16
Agility	4.08	4.09	3.94	3.49	3.7	3.58	4.58	4.02
Improvement of confidence	4.06	4.13	3.79	3.36	3.77	3.42	4.6	4.02
Education during deep exist sitting	4.18	4.16	3.96	3.35	3.46	3.33	4.58	3.82
Education control of horse	3.86	3.79	3.67	3.25	3.79	3.43	4.26	4.2
Exercise of riding horse	4.3	4.22	3.92	3.42	3.65	3.47	4.36	3.9
Exchange of position	4.3	4.36	3.95	3.4	3.58	3.34	4.36	3.9
A prone position of riding horse	4.26	4.13	3.79	3.1	3.33	3.15	4.54	3.84
Together of riding horse	4.17	4.16	3.98	3.37	3.43	3.13	3.76	3.6
Monoplegia	3.9	3.88	3.84	3.19	3.43	3.05	4.5	4.12
Hemiplegia	3.9	3.86	3.84	3.2	3.43	3.05	4.52	4.12
Paraplegia	3.9	3.78	3.78	3.07	3.33	2.96	4.52	4.14
Diplegia	3.85	3.75	3.77	3.02	3.39	2.93	4.38	4.04
Quardriplegia	3.77	3.74	3.75	3.02	3.39	2.92	4.46	4.02
Cerebral palsy	3.77	3.78	3.65	3.04	3.47	2.96	4.48	4.06
Hypertonic cerebral palsy	3.77	3.8	3.65	3.07	3.2	3.03	4.44	3.98
Hypotonic cerebral palsy	3.82	3.74	3.72	3.11	3.3	3	4.46	4.06
Failure of muscular	3.84	3.62	3.68	3.15	3.4	3.03	4.4	3.96
Autism	3.98	3.67	3.5	2.95	3.51	3.17	4.42	4.26
Mental retardation	4.01	3.61	3.45	2.92	3.39	3.13	4.42	4.16
110cm below height of riding people	3.66	3.45	3.39	2.7	3.56	3.43	4.6	4.5
110cm between 140cm height of riding people	3.66	3.45	3.41	2.7	3.63	3.43	4.6	4.48
More than 140cm height of riding people	3.62	3.35	3.43	2.79	3.66	3.36	4.6	4.42

DISCUSSION

The The domestication of horses has provided many benefits for humans. For example, the horse offers humans power for transporting materials and assists in many human labor functions. Since ancient times, use of horse has been common worldwide. Evidence of such use can be found in many articles from the past to the present. The horse played a key role in battle, for instance. Horses were used to transport war materials, which allowed the widening of battle areas while providing the cavalrymen effective means to attack the enemy. Of course, the horse can provide pleasure and emotional support as well.

The use of horses has created a variety of businesses within the horse industry. The horse industry encompasses the economic activities associated with producing, raising, training, distributing, and using horses as well as industry sectors, such as horse breeding, horse racing and horseback riding. The horse is thought of as a distinctive domestic animal in contrast to ordinary domestic animals, such as pigs, cattle and poultry. However, the horse is not raised only for consumption purposes. In the context of environmental preservation, the horse is eco-friendly as it does not pollute the environment. Horses produce less methane gas contributing to the greenhouse effect compared to other domestic animals.

Presently, the horse industry in Korea has received little support. According to a report in Korea that surveyed the horse industry in 2009, 28,718 horses were raised from 1,742 farms, which occupied 2% of the total stockbreeding farmhouses. Specifically, the number of horses used for horse racing or events associated with racing was about 6,000; the number of horses used for horseback riding was about 5,000. In addition, 900 horses were processed for meat consumption. In other words, the horse industry in Korea remains a minor business. The market scale directly associated with horses in 2009 was estimated at 2 trillion 870 billion Korean KRW and indirectly at 697.8 billion KRW. Thoroughbreds occupy a large percentage of the horse industry in Korea. However, the economic scale is considerably less compared to other advanced countries, such as the United States, the United Kingdom, Australia, France, Germany, Austria and Japan. Fortunately, the government of Korea has recognized the importance of the horse industry, promising effective policies for its promotion. The Jeju Special Self-governing Province has contributed to the promotion of the horse industry. For example, in-depth discussions have been conducted for several years to secure continued and systemic development of the horse industry. In addition, the Jeju Special Self-governing Province has enacted legislation to secure continued policies for the development of horse businesses. One act includes revitalization of horseback riding in the context of promoting employment. Meanwhile, a local autonomous entity is attempting to promote horse businesses and to develop programs in horseback riding. Furthermore, professional education courses have been developed in high schools and higher educational institutes, such as colleges and universities. Such efforts to promote public awareness of the horse industry may bring future prosperity.

Jeju has distinguished itself as the best environment for horse breeding. Presently, around 66% of horse-raising farms are located in Jeju. Jeju also holds 77% of the raised horse breeds in Korea. Thus, Jeju is a center of horse production with an increasing number of raised horses. The environment of Jeju encourages farmers to raise horses, and the horse industry itself further grabs their attention. Jeju is able to convince farmers to breed bred horses because 48% of the land is grassland, and the province has ideal weather conditions and infrastructure.

Among horse-associated businesses, horseback riding may be one of the fastest emerging sectors. Before discussing horse riding, understanding the word "horse" is necessary. *Horse* means *hippos* in Greek and *equus* in Latin. The term *horse* originated from *equine*. These words generally infer "doing something with a horse, considering a horse and of a horse." In addition, *equestrian* is understood to mean "a man riding horse." A *hippophile* in Greek means "a person who loves a horse." *Hippophile* also refers to a type of riding club that existed in the past. Naturally, horseback riding is a distinctive exercise that requires a live horse. Furthermore, the sense of unity for both humans and horses is an important condition. From ancient times, horse riding has existed as a life sport to develop the spirit. Horseback riding is hard exercise that develops body muscle and is a very sophisticated exercise because it stimulates minor muscles and the body sensors in charge of balance and flexibility. Furthermore, horse riding helps to strengthen character, including boldness and soundness, because sharing activity with a live animal can generate a respect for life.

The history of the horse may be longer than the history of humans. Horses appeared in the Mesozoic Era around 600,000 years ago. Humans that lived in the pre-historic ages hunted horses. However, humans eventually recognized that the horse was a useful animal with diverse purposes. Therefore, modern day humans began to catch the horse and train it, resulting in the ability to move to faraway places more easily. Modern day humans were able to obtain a higher amount of labor from the horse than labor from humans. Horseback riding may have started during the same era of domesticating the horse to such purposes. After the adaptation of the horse, humans may have understood the requirements of developing horse training techniques. These efforts paved the way for horseback riding as we know it today.

In 1912, the Federation Equestre Internationale (FEI) was established in Paris to unite world equitation. Finally, horseback riding was adopted in 1900 as a formal Olympic sport during the 2nd modern Olympics in Paris. On the Korean Peninsula, the horse was used from the Kojoson Era. Formal records suggest that the common use of the horse in Korea started during the Three Kingdom Era when horses were used for faster transportation and warfare. The main highlights of horse riding in Korea are centered around the formation of the Korean Student Dressage Association in 1945 and the Korean Equestrian Federation in 1948. Korea also participated in the 15th Helsinki Olympics, 17th Rome Olympics (1960), 18th Tokyo Olympics (1964), 24th Seoul Olympics (1988), 25th Barcelona Olympics (1992), and the 28th Athens Olympics (2004).

Horseback riding is an attractive entertainment activity, and the horse is a good companion. Horse riding can lead to a healthy body and spirit, resulting in improvements in life quality. For example, horse riding strengthens the upper body, provides flexibility for the waist, improves concentration, improves gastrointestinal track movement, improves the body's balancing sensors, increases lung capacity, generates encouragement, strengthens the pelvic area, prevents arthritis, and affects weight loss. While horseback riding, energy consumption increases 500 times more than during jogging.

Recently, recreational horseback riding therapy (HBRT) has been in the spotlight because of the diverse benefits that can be obtained from horseback, riding. For a long time, horseback riding was only allowed for able-bodied individuals. However, since the 1900's, there has been an attempt to use horse riding to rehabilitate people living with disabilities. Rehabilitation practices began in the UK and spread to the other countries. HBRT is an attempt to heal the disabled, such as physically and mentally handicapped people and those with developmental disabilities. This rehabilitation approach is expected to improve life quality via experiences with horses that can provide pleasure and happiness. Furthermore, the similarities between the horse's gait and human walking helps in the rehabilitation of disabled persons. During horseback riding, the horse dynamically influences the human nervous system and creates a link between the horse and human. This effect mimics a motor response from the cerebrum that occurs in normally-developed humans. Meanwhile, the sophisticated response of the horse induced by human manipulation is a form of communication between the horse and human. The continued reciprocal signals provide disabled individuals with the experience of motion sensation. In particular, horse riding is a balancing exercise, thus stimulating balancing of human sensors. The stimulation of the balancing sensor in a disabled person may act to correct incorrect perceptions in the sense of balance, a concept known as "compensatory balance." Specifically, compensatory balance counters the incorrect balance of a disabled person and generates the sense of balance in the cerebrum seen in a normal person.

Rehabilitation with horse riding in Korea has been an issue. Many farms have started to breed horses. However, there was a lack of infrastructure for horseback riding. In particular, guidelines for HBRT are absent. Thus, the present study was designed to prepare the establishment of guidelines for HBRT. In this study, horses and dominant crossbred Jeju horses raised in the Jeju Special Self-governing Province were surveyed and recognized. These results were similar to thoroughbred horses (withers height: 159±6.1 cm) and Hokkaido native horses (withers height: 129±2.3 cm) (Matsuura *et al.*, 2003). The withers height, back length, and forelimbs of Andalusia horses were smaller than German horses (i.e., Hanoverian, Oldenburger, and Werphalian) and had smaller vertical amplitude than the German horses (Barrey et al., 2002). When examining Jeju horses, four types of horses were classified: short body and narrow chest width (SN), short body and wide chest width (SW), tall body and narrow chest width (NW), and tall body and wide chest width (TW). The body shape of the horse was defined through preliminary data collection, and the data were obtained from the Jung-e and Song Dang horse riding club facilities. Height at withers, length and chest width were used as the main criteria for classifying the horses. We measured and recorded the figures of the classified horses. The measured heights at withers, length and chest width were analyzed with the CLUSTER Procedure Single Linkage Cluster Analysis on a SAS system. SAS calculated statistical significance.

Representative horses were selected for further analysis, and the selected horses were analyzed for gait trait based on the horse classification. Assessments were conducted by a qualified professional instructor on the club guidelines set at 3 m width and 40 m distance end to end of a straight track. All tests were recorded with a high-speed digital camcorder (60 frames/sec, VX-2000, Sony). Two sets of 3-D accelerometers with two sensors were used in the experiment. The experiment measured 3-D rebound on three jog trot during walking (1.5 m/sec) and trotting (3.0 m/sec). Repeated preliminary driving (2-3 times) was conducted to calibrate the X-axis for forward direction. The recording of both forms of 3-D data was started simultaneously when walking began. The walking was completed once in a straight line. Then, the recorded data was saved. In the same manner, two horse walks, two sitting trots and two riding trots were recorded. The driving time to finish each test was estimated at 20-25 minutes. The results from the tests were analyzed with a Loger Pro 3 (Vernier, Korea), and the data was focused on the strength of rebound. With the results, the classified horses were examined for rehabilitative properties through a riding test with an internationally qualified HBRT instructor. The results were scored through a questionnaire that followed the RHRA's standard manual.

A number of studies have analyzed stride parameters like frequency, duration, regularity or acceleration force during stance, propulsion and swing phases with accelerometers for different purposes, including the following: detection of lameness

(Barrey et al., 1994 and Olsen et al., 2012), performance evaluation and improvement (Biau et al., 2002 and Leleu et al., 2004), minimization of injury risk (Ratzlaff et al., 2005 and Kruse et al., 2012) and general understanding of equine locomotion (Schamhardt and Merkens, 1994 and Barrey, 1999). However, no references could be found on gait determination in horses based on basic acceleration values.

In the current study, walking gait was characterized with and without a horseman. Type 1 and Type 2 with horseman and Type 2 without a horseman showed a longer jog trot. The increased pro-rata duration of the jog trot was observed when there was an increase in jog trot length. An extension of the current cycle and since cycle also occurred when there was increased jog trot length. However, in Type 4, both with and without horseman trials resulted in the shortest length, duration, current cycle and since cycle during the jog trot. During the sitting trot, the length of the jog trot was long in Type 1 and Type 2 with the horseman and in Type 2 without the horseman. An increased duration, current cycle and since cycle were observed by pro-rata with an increase in the length of the jog trot. In Type 4, the length, duration, current cycle and since cycle were the shortest in the experiment. Collectively, most results in the sitting trot showed similarities to the riding trot, except in the analysis of Type 3. The length of the longest jog trot was in Type 1 and Type 2 with the horseman. Duration, current cycle and since cycle of the jog trot also increased with pro rata increases in the length of the jog trot. Differences in Type 3 and Type 4 were observed in the analysis. Length, duration, current cycle and since cycle of the jog trot were decreased. Put simply, Type 2 had a short body, chest width and height at wither lengths and longer pre and post steps; length, duration, current cycle and since cycle of the jog trot lengths than Type 4. In contrast to Type 2, Type 4 had a relatively long body chest width and height at wither lengths. According to the literature, the moving speed suitable for riding lessons for disabled individuals was set at 1.5 m/sec for walking and 3.0 m/sec for trotting (Matsuura et al., 2003). However, equine oscillation was changed according to the moving speed.

The evaluation of rebound in the horseman and selected horses were assessed by measuring 3-D acceleration during horse riding. In Type 2, the walking, riding, and sitting trots revealed the fastest acceleration on the X-axis. Type 4 showed the slowest acceleration on the X-axis. However, the most frequent rate of rebound was observed in Type 4. Collectively, the present study recognizes that rebound and acceleration had similarities between horseman and horse. When comparing Type 2 and Type 4, Type 2 had a shorter body than Type 4. The shorter body showed fast acceleration with greater movement in horseback riding.

According to the RDA, the instructor must select the horse with a conformation that suits the individual rider. Conditions must be evaluated, including wide or narrow horse, short or long stride, and much or little back movement. The instructor must also match the height of the horse to the helper (RDA, 1990). The Garran version of the Highland pony, Fell pony, Connemara pony, Dale pony, and Welsh Cobs are breeds of British native horses; they have been deemed suitable horses for instruction by the RDA. In our study, the Jeju crossbred horse conformation pattern is similar. The British native horses are similar to the short and wide horses used in our study. The short and wide horses were evaluated more highly as horses for therapeutic riding than the other horses. Hokkaido native horses and Kiso horses are also short and wide horses. Therefore, these Japanese native horses have the potential to become good horses for therapeutic riding (Matsuura et al., 2008).

The candidate horses were selected by isolating the gait trait characteristics within the classified data. The selected horses were selected in the examination for

HBRT. We evaluated and selectively scored twenty-five items: 1) the effect on the sense of balance; 2) the effect on skeletal muscle relaxation; 3) the effectiveness of exercise; 4) the coordination of muscle exercise; 5) quickness; 6) the improvement of self-confidence; 7) the effect on deep position riding; 8) control efficiency of the tested horses; 9) the application of horseback riding in the context of exercise; 10) the feasibility of posture changing; 11) the horseback prone position; 12) tandem riding with an instructor; 13) the effect on monoplegia; 14) the effect on hemiplegia; 15) the effect on lower limbs paralysis; 16) the effect on quadriplegia; 17) the effect on athetoid cerebral palsy; 18) the effect on hypertonic cerebral palsy; 19) the effect on hypotonic cerebral palsy; 20) the effect on ataxia; 21) the effect on autistic children; 22) the effect on mentally retarded children; 23) the effect on horsemen less than 110 cm tall; 24) the effect on horsemen between 110 and 140 cm tall; and 25) the effect on horsemen more than 110 cm tall.

The present study obtained reliable data from the tested horses, which be used for HBRT. In general, for HBRT, the walking and trotting of Type 4 received the best scores. In particular, the walking of Type 4 showed extraordinary results for most subsections. Type 4 showed long measurement for height at wither, chest width and length of the body. The jog gait distance, duration, pillar period and actual period of Type 4 were relatively short. However, less acceleration and considerable frequency were observed, which offered the horsemen comport during horseback riding. Therefore, the characteristics of Type 4 horses received the best evaluation for HBRT. In addition, the walking of Type 1 make it a good candidate for HBRT, and the best effect on the horses was tandem horse riding. Nonetheless, the walking and trotting of Type 4 should make it a first choice for HBRT for the subsections of monoplegia, hemiplegia, lower limb paralysis, quadriplegia, athetoid cerebral palsy, hypertonic cerebral palsy, hypotonic cerebral palsy, ataxia, autistic children and mentally retarded children.

The present study evaluated the Jeju horse for HBRT. In the process of this study, the Jeju horse was classified and documented. The criteria examined in this study can be used to improve horse breeds and the selection of an optimal horse for HBRT. The results demonstrate that physically and mentally disabled individuals can be attended to using horses without issues or conflicts in HBRT. The development of the HBRT program can most certainly be facilitated.

요 약

승용 제주산마 체형조사 및 보행특성 분석

제주도내 승마장에서 승마용말로 사용 중인 제주산마를 무작위로 100두를 선정하여 체형 조사를 실시하였으며, 개체 중 제주산마 체형과 관련하여 관련법규의 소형마 기준에 따라 94두를 선별하여 체형을 조사하였으며,

1. 체형 조사결과 : 몸집이 작고 흉폭이 좁은 형태(SN : short and narrow), 몸집이 작고 흉폭이 넓은 형태(SW : short and wide), 몸집이 크고 흉폭이 좁은 형태(TN: tall and narrow), 몸집이 크고 흉폭이 넓은 형태(TW : tall and wide)로 나누었다. 각 타입별 체형을 통하여 재활승마에 가장 적합한 대상축을 선발하기 위한 기준을 준비하였다.

2. 보행특성 : 평보, 좌속보 및 경속보에서는 기승 시 type 1, 2에서 길게 나타나는 것을 보였고, 무기승시에는 type 2에서 길게 나타나는 것으로 나타났다. 완보의 지속시간 또한 완보의 길이와 비례하여 나타나는 특성을 나타냈으며, 현주기 및 지주기또한 비례함을 보여주었다. 반면 type 4에서는 상대적으로 완보길이, 완보지속시간, 현주기 및 지주기가 가장 작은 값을 보여주었다. 결과를 정리하여 보면, type 2는 체장, 흉폭, 체고가 작은 반면에 type 4는 상대적으로 체장, 흉폭, 체고가 큰 것으로 나타났다. 같은 거리를 걷는 동안의 운동 특성을 생각해보면, type 2가 type 4에 비하여 전 스텝의 길이, 후 스텝의 길이, 완보의 길이, 완보지속시간, 현주기 및 지주기의 길이가 길게 나타냄을 알 수 있었다

3. 기승자와 공시마의 가속도 측정 : 반동과 가속도는 유사한 경향성을 가지고 있으며, 가속도가 빠른 타입은 체형조사 결과상으로 볼 때 type 2는 type 4에 비하여 체고, 흉폭 등이 작은 형태로 나타났다. 이는 체형이 작고 매끄러운 경우 움직임

크기가 크고 가속도가 빠르다는 것을 알 수 있었다.

4. 재활승마 효과 : 전반적으로 type 4 평보 및 속보에서 많은 효과가 나타났으며, 특히 type 4 평보에서는 전반적인 항목에서 효과가 좋음을 알 수 있었다
승마에 적합한 제주 승용마 보행 특성을 분석하여 Type 4가 대부분의 항목에서 승마에 적합한 승용마로 좋은 점수를 받았다. 체형적 특성으로 체고, 흉폭, 체장의 길이가 길었다. 평보, 좌속보, 경속보시 보행특성을 살펴보면, 전반적으로 완보길이, 지속시간, 현주기, 지주기가 적음을 알 수 있었으며, 가속도는 가장 작고 반동은 많은 것을 알 수 있었다. 이러한 경향을 결론 지어 보면 재활승마의 높은 점수는 안락함과 편안함을 느끼는 기승자의 경향이 있다는 것을 알 수 있다. 짧게 많이 걷는 방향이 많은 점수를 받을 수 있다는 것이다.

승용마의 체계적인 개량을 위해서는 우선 한국인의 체형에 알맞은 체형 분류가 이뤄져야 한다. 이번 연구에서는 재활승마에 초점을 맞추었으며, 한국인의 체형이 다양하고 남녀노소에 따른 기준 체형이 다르므로 우선 제주산마에서 한국인에 가장 적합한 체형을 분류하여 기준을 제시하여 개량사업을 추진할 수 있는 기준이 만들어져야 한다. 금번 연구를 통하여 기본적인 분류법 및 보행특성을 알아봤으므로 기승자의 체형별로 분류와 승마 만족도를 알 수 있는 연구가 계속되어야 할 것이다. 이러한 기반이 만들어 진다면 정부의 재활승마전용마 품종개발이 가능해 질 것이며, 보급시책의 기술적인 지원이 가능해 질 것이다.

주요어 : 승용마, 체형분석, 반동체크, 보행특성, 제주산마, 재활승마

REFERENCES

Abourachid, A (2003). A new way of analysing symmetrical and asymmetrical faits in quadrupeds. C. R. Biol. 326:625-630.

Alexander, R.M (1984). Walking and running. Am. Scient. 72:348-354.

Anderson, M. K., Friend, T. H., Evans, J. W., and Bushong, D. M. (1999). Behavioral assessment of horses in therapeutic riding programs. Appl. Anim. Behav. Sci. 63: 11.24.

Art, T., Desmecht, D., Amory, H., Lekeux, P (1990). Synchronization of locomotion and respiration in trotting ponies. Zentralbl. Veterinarmed. A. 37:95-103.

Attenburrow, D.P (1982). Time relationship between the respiratory cycle and limb cycle in the horse. Equine. Vet. J. 14:69-72.

Back, W., Barneveld, A., Schamhardt, H.C., Bruin, G., Hartman, W (1994). Longitudinal development of the kinematics of 4-, 10-, 18- and 26-month-old Dutch Warmblood horses. Equine. Vet. J. 17:3-6.

Back, W., Van Den Bogert, A.J., Van Weeren, P.R., Bruin, G., Barneveld, A (1993). Quantification of the locomotion of Dutch Warmblood foals. Acta. Anat. 146:141-147.

Barrey, E (1999). Methods, applications and limitations of gait analysis in horses. Vet. J. 157:7-22.

Barrey, E., Desliñes, F., Poirel, D., Biau, S., Rivero, J.L., Langlois, B (2002). Early evaluation of dressage ability in different breeds. Equine. Vet. J. 34:319-324.

Barrey, E., Hermelin, M., Vaudelin, J.L., Poirel, D., Valette, J.P (1994). Utilisation of an accelerometric device in equine gait analysis. Equine. Vet. J. 17:7-12.

Becker, A.C., Stock, K.F., Distl, O (2011). Genetic correlations between free movement and movement under rider in performance tests of German Warmblood horses. Livestock. Sci. 142: 245-252.

Biau, S., Lemaire, S., Barrey, E (2002). Analysis of gait transitions in dressage horses using wavelet analysis of dorso-ventral acceleration. Pferdeheilkunde. 18:343-350.

Biewener, A.A., Taylor, C.R (1986). Bone strain: a determinant of gait and speed? J. Exp. Biol. 123:383-400

Buchner, H.H., Savelberg, H.H., schamhardt, H.C., Merkens, H.W., Barneveld, A (1994). Kinematics of treadmill versus overground locomotion in horses. Vet. Q. 16:S87-S90.

Cano, M. R., Vivo, J., Miro, F., Morales, J. L., and Galisteo, A. M. (2001). Kinematic characteristics of Andalusian, Arabian and Anglo-Arabian horses: a comparative study. Res. Vet. Sci. 71: 147.153.

Cavagna, G.A., Saibene, F.P., Margaria, R (1964). Mechanical work in running. J. Appl. Physiol. 19:249-256.

Cavagna, G.A., Heglund, N.C., Taylor, C.R (1977). Mechanical work in terrestrial locomotion: two basic mechanisms for minimizing energy expenditure. Am. J. Physiol. 233:R243-R261.

Clayton, H.M (1989). Terminology for the description of equine jumping kinematics. J. Equine. Vet. Sci. 9:341–348.

Clayton, H.M (1997). Classification of collected trot, passage and piaffe based on temporal variables. Equine. Vet. J. 23:54–57.

Clayton, H.M (1994a). Comparison of the collected, working, medium, and extended canters. Equine. Vet. J. 17:16-19.

Clayton, H.M (1994b). Comparison of the stride kinematics of the collected, working, medium, and extended trot. Equine. Vet. J. 26:230-234.

Clayton, H.M (1995). Comparison of the stride kinematics of the collected, medium, and extended walks in horses. Am. J. Vet. Res. 56:849-852.

Clayton, H.M., Bradbury, J.W (1995). Temporal characteristics of the fox trot, a symmetrical equine gait. Appl. Anim. Behav. Sci. 42:153-159.

Corley, J.M., Goodship, A.E (1994). Treadmill training induced changes to some kinematic variables measured at the canter in Thoroughbred fillies. Equine. Vet. J. 17:20–24.

Crawford, W.H., Leach, D.H (1984). The effect of racetrack design on gait symmetry of the pacer. Can. J. Comp. Med. 48:374-380.

Crevier-DenoixN.,PourcelotP.,RicardA.,2006.Programme "Morphométrie 3-D": Résultatsobtenus, Perspectives d'utilisation. Rapport de fin de projet remis à l'Association Nationale du Selle Français, pp.54.

Dawson, T.J., Taylor, C.R (1973) Energetic cost of locomotion in kangaroos. Nature 246:313-314.

Deuel, N.R., Lawrence, L.M (1986). Gallop velocity and limb contact variables of quarter horses. J. Equine. Vet. Sci. 6:143-147.

Deuel, N.R., Lawrence, L.M (1987). Effect of urging by the rider on equine gallop stride limb contacts. Proceedings of the 10th Equine Nutrition and Physiology Symposium, pp.487-492.

Deuel, N.R., Park, J.J (1990). The gait patterns of Olympic dressage horses. Int. J. Sport. Biomech. 6:198-226.

Diedrich, F.J., Warren Jr, W.H (1995) Why change gaits? The dynamics of the walk-run transition. J. Exp. Psychol. Hum. Percept. Perform. 21:183-202.

Drevemo, S., Dalin, D., Fredricson, I (1980). Equine locomotion. Part 1. The analysis of linear and temporal stride characteristics of trotting standardbreds. Equine. Vet. J. 12:60-65.

Dutto, D.J., Hoyt, D.F., E.A., Wickler, S.J (2004). Ground reaction forces in horses trotting up an incline and on the level over a range of speeds. J. Exp. Biol. 207:3507-3514.

Evans, D.L., Silverman, E.B., Hodgson, D.R., Eaton, M.D., Rose, R.J (1994). Gait and respiration in Standardbred horses when pacing and galloping. Res. Vet. Sci. 57:233-239.

Fredricson, I., Drevemo, S., Dalin, G., Hjerten, G., Bjorne, K., Rynde, R., Franzen, G (1983). Treadmill for equine locomotion analysis. Equine. Vet. J. 15:111-115.

Gunn, H (1987). Muscle, bone and fat proportions and muscle distribution of Thoroughbreds and other horses.

Hair, Jr J. F., Anderson, R. E., Tatham, R. L. and Black, W. C (1995). Multivariate Data Analysis with Readings, Fourth Ed., Prentice-Hall.

Hildebrand, M (1965). Symmetrical gaits in horses. Science. 150:701-708.

Hodson, E.F., Clayton, H.M., Lanovaz, J.L (2000). The forelimb in the walking horse. Part 1. Kinematics and ground reaction forces. Equine. Vet. J. 32:287-294.

Hodson, E.F., Clayton, H.M., Lanovaz, J.L (2001). The hind limb in the walking hores. Part 1. Kinematics and ground reaction forces. Equine. Vet. J. 33:38-43.

Holmström, M., Magnusson, L.E., Philipsson, J (1990). Variation in conformation of Swedish Warmblood and conformational characteristics of elite sport horses. Equine. Vet. J. 22: 186-193.

Holmström, M., Philipsson, J (1993). Relationships between conformation, performance and health in 4-year-old Swedish Warmblood Riding Horses Livest. Pro. Sci. 33:293-312.

Holmström, M., Fredricson, I., Drevemo, S (1995). Biokinematic effects of collection on the trotting gaits in the elite dressage horse. Equine. Vet. J. 27:281-287.

Hörnicke, H., Meixner, R., Pollman, U (1987). Respiration in exercising horses. In Equine Exercise Physiology, eds. D. H. Snow, S. G. B. Persson and R. J. Rose, pp. 7-16, Granta Editions.

Hoyt, D.F., Taylor, C.R (1981). Gait and energetics of locomotion in horses. Nature 292, 239.

Hreljac, A (1995) Determinants of the gait transition speed during human locomotion: kinematic factors. J. Biomech. 28:669-677.

Imus, B (1995). Heavenly Gaits: The Complete Guide to Gaited Riding Horses. CrossOver Publications, New York, pp. 11-24.

Jeffcott, L. B., Rossdale, P. D., Freestone, J., Frank, C. J., Towers-Clark, P. F (1982). An assessment of wastage in Thoroughbred racing from conception to 4 years of age. Equine. Vet. J. 14:185-198.

Kayar S, Hoppeeler H, Lindstedt S, Claassen H, Jones J, et al (1989). Total muscle mitochondrial volume in relation to aerobic capacity of horses and steers. Pflugers Archiv. 413:343-347.

Ker, R.F., Bennett, M.B., Bibby, S.R., Kester, R.C., Alexander, R.M (1987) The spring in the arch of the human foot. Nature 325:147-149.

Koenen,E.P.C.,vanVeldhuizen,A.E.,Brascamp,E.W (1995). Genetic parameters of linear scored conformation traits and their relation to dressage andshow-jumping performance in the Dutch Warmblood Riding Horsepopulation.Livest.Prod.Sci.43:85-94.

Korea Racing Authority (2010). Horse industry-MICE win-win srategy.

Kram, R., Domingo, A., Ferris, D.P (1997) Effect of reduced gravity on the preferred walk-run transition speed. J. Exp. Biol. 200:821-826.

Langlois, B., Froidevaux, J., Lamarche, L., Legault, C., Legault, P., Tassen-court, L., Theret, M (1978). Analyse des liaisons entre la morphologieet l'aptitute au gallop au trot et au saut d'opstacles chez le Cheval. Ann. Genet. Sel. Anim. 10:443-474.

Leleu, C., Bariller, F., Cotrel, C., Barrey, E (2004). Reproducibility of a locomotor test for trotter horses. Vet. J. 168:160-166.

Leach, D.H (1993). Recommended terminology for researchers in locomotion and biomechanics of quadrupedal animals. Acta. Anatomica. 146:130-136.

Leach, D.H (1987). Locomotion of the athletic horse. In Equine Exercise Physiology 2, eds. J.R. Gillespie and N.E. Robinson, pp.516-535, Davis, ICEEP publications.

Leach, D.H., Springings, E.J (1987). Gait fatigue in the racing Thoroughbred. J. Equine. Med. 3:436-443.

Leach, D.H., Cymbaluk, N.F (1986). Relationship between stride length, stride frequency, velocity and morphometrics of foals. Am. J. Vet. Res. 47:2090-2097.

Leach, D.H., Ormrod, K., Clayton, H.M (1984). Standardised terminology for the description and analysis of equine locomotion. Equine Vet. J. 16:522-528.

Magnusson, L.E.,Thafvelin,B (1990). Studies of the conformation and related traits of standardbred trotters in Sweden. J. Anim. Breed. Genet. 107:135-148.

Matsuura, A., Takita, N., Shingu, Y., Kondo, S., Matsui, A., Hiraga, A., Asai, Y., Hata, H., and Okubo. M. (2003). Rhythm Analysis for Movements of Horse and Rider on a Treadmill by Sequential Still VTR Pictures. J. Equine Sci. 14: 125.131.

Matsuura, A., Masumura, K., Chiba, Y., Nakatsuji, H., and Kondo, S. (2005). Analysis of rhythmical movements of both horse and the rider using accelerometer. Animal Behaviour and Management 41: 5.11.

Mawdsley, A., Kelly, E. P. ,Smith, F. H., Brophy, P.O (1996). Linearassessment of the Thoroughbred horse : an approach to conformation evaluation. Equine. Vet. J. 28:461-467.

Margaria, R (1938) Sulla fisiologia e specialmente sul consumo energetico della marcia e della corsa a varia velocita ed inclinazione del terreno. Atti Academia Nazionale dei Lincei Memorie 7:299-368.

Minetti, A.E (2000) The three modes of terrestrial locomotion. In Biomechanics and biology of movement (ed. B. R. Macintosh, B. M. Nigg & J. Mester), pp. 67-78. Champaigne, IL: Human Kinetics.

Minetti, A.E., Ardigo, L.P., Reinach, E., Saibene, F (1999). The relationship between mechanical work and energy expenditure of locomotion in horses. J. Exp. Biol. 202:2329-2338.

Olsen, E., Haubro Andersen, P., Pfau, T (2012). Accuracy and precision of equine gait event detection during walking with Limb and trunk mounted inertial sensors. Sensors. 12:8145-8156.

Persson, S.G.B., Essen-Gustavsson, B., Lindholm, A (1991). Energy profile and locomotor pattern of trotting on an inclined treadmill. In Equine Exercise Physiology 3, eds. S.G.B. Persson, A. Lindholm and L.B. Jeffcott, pp.231-238, Davis, CA, ICEEP publications.

Poole, D (2004). Gurrent concepts of oxygen transport during exercise. Equine and Comparative Exercise Physiology. 1:5-22.

Podhajsky, A (Ed.) (1976). La Equitación. Velázquez, Madrid, pp. 34-144.

Professional Association of Therapeutic Horsemanship International (2010). Registered Instructor On-Site Workshop Manual. pp 34-36.

Prilutsky, B.I., Gregor, R.J (2001) Swing- and supportrelated muscle actions differentially trigger human walk-run and run-walk transitions. J. Exp. Biol. 204:2277-2287.

Ratzlaff, M.H., Wilson, P.D., Hutton, D.V., Slinker, B.K (2005). Relationships between hoof-acceleration patterns of galloping horses and dynamic properties of the track. Am. J. Vet. Res. 4:589-595.

Raynor, A.J., Jia Yi.C., Abernethy, B., Jin Jong, Q (2002) Are transitions in human gait determined by mechanical, kinetic or energetic factors? Hum. Movement Sci. 21:785-805.

Rivero, J.-L.L., Clayton, H.M (1996). The potential role of the muscle in kinematic characteristics. Pferdeheilkunde 12:635-640.

Roepstorff, L (2012). The development of clinical tools based on biomechanical research. Vet. J. 192:129-130.

Robilliars, J.J., Pfau, T., Wilson, A.M (2007). Gait characterization and classification in horses. J. Exp. Biol. 210:187-197.

Rossdale, P. D., Hopes, R., Wingfield Digby, N. J., Offord, K (1985). Epidemiological study of wastage among racehorses 1982 and 1983. Vet. Rec. 11:66-69.

Saastamoinen, M.T., Barrey, E (2000). Genetics of conformation locomotion and physiological traits. In: Bowling, A.T., Ruvinsky, A. (Eds.), The genetics of the horse. Wallingford. UK. 439-472

SAS Institute Inc. (1999), SAS/STAT User's Guide, Version 8, Cary, NC: SAS Institute Inc.

SAS Institute Inc. (1999), SAS Screen Control Language: Usage, Version 8, Cary, NC: SAS Institute Inc.

Schamhardt, H.C., Merkens, H.W (1994). Objective determination of ground contact of equine limbs at the walk and trot: comparison between ground reaction forces, accelerometer data and kinematics. Equine Vet. J. 26:75-79.

The Riding for the Disabled Association (1990) Horses, Ponies and Donkeys. pp. 43-50. In: The RDA official manual, The Kenilworth Press, London.

Valette, J.P., Barrey, E., Auvinet, B., Galloux, P., Wolter, R (1992). Comparison of track and treadmill exercise tests in saddle horses: a preliminary report. Annale de Zootechnie 41:129-135.

Valette, J.P., Barrey, E., Wolter, R (1990). Influence des deux composantes de la vitesse (fréquence et longueur des foulées) sur le métabolisme énergétique musculaire chez le poney. Annale de Zootechnie 39:187-192.

Weatherby, J (1791). An Introduction to a General Stud Book. Weatherby and Sons, London..

Weller, R., Pfau, T., Babbage, D., Brittin, E., May, S.A., Wilson, A.M. (2006). Reliability of conformational measurements in the horse using a three-dimensional motion analysis system. Equine. Vet. J. 38:610-615.

Wilson, B.D., Neal, R.J., Howard, A (1988). The gait of pacers. Part 1. Kinematics of the racing stride. Equine. Vet. J. 20:341-346.

Young L, Marlin D, Deaton C, Brown-Feltner H, Roberts C. (2002). Heart size estimated by echocardiography correlates with maximal oxygen uptake. Equine. Vet. J. 34:467-471.

Zips, S., Peham, C., Scheidl, M., Licka, T., Girtler, D (2001). Motion pattern of toelt of Icelandic horses at different speeds. Equine. Vet. J. 33:109-111.

APPENDIX

1. The Jeju Riding Course Investigation

A survey was conducted to collect basic data on Jeju riding courses. Thirty-five courses were investigated in terms of their present condition, method of fodder cost, preference of body type, and listening difficulties at the course.

Before starting this study, participants from the Jeju Equestrian Club were surveyed regarding the status of the province. Equestrian identify and report on-site and made to identify the relevant studies and basic data was intended to take advantage of. They were asked about how horses were fed, and daily feeding accounted for 43% of the results and 4-6 kg of limited feeding accounted for about 40%. This means that about 83% were self-pay, or 4-6 kg, confirming that the main use of the company has shown that the Nong-hyuo (Figures 1 and 2). This riding horse one day to mount of forage results subjected to 61% and limited self-catering 4-5 kg of feed accounts for about 25%. This means that about 86% of the benefit is voluntary, or 4-5 kg. This can confirm that the production methods are leased or owned by Jeju farmers. Pasture-grown forage accounts for a large part, 32% of the purchase. Supply and demand shows that about 41% was Roadster; this result was the highest since the purchase, and the purchase, including training, was 58% (Figures 3 and 4). After training, the riding horse can also be used for a significant period of time. Though research has been carried out previously, this material is preferred because the equestrian information is comprehensive. Body type prior to the survey results, based on 64% of the large-sized large ferocious form (TW: tall and wide) is rider psychological and physical stability can be attributed to giving (Figures 5 and 6).

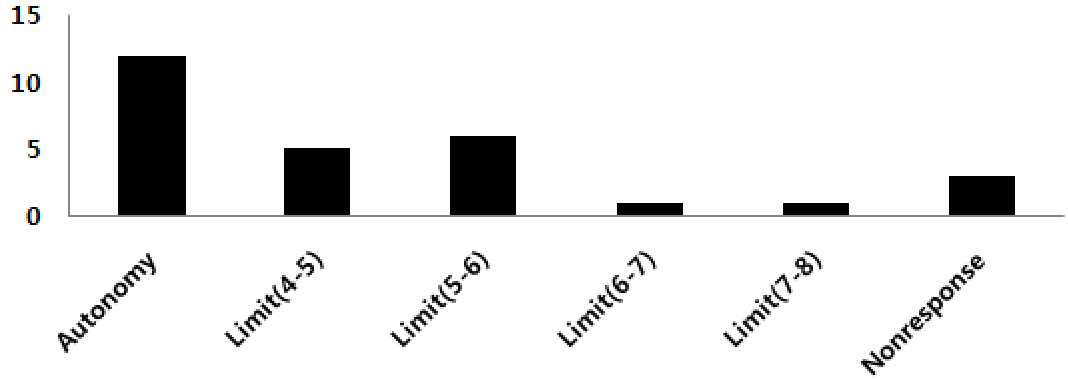


Figure 1. The Results of the riding horse daily feed ration survey.

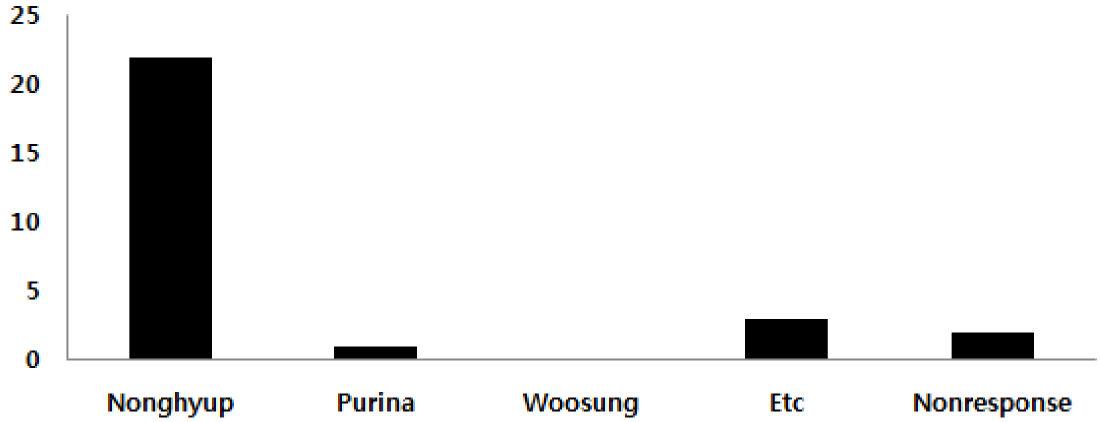


Figure 2. Feed ration company survey results.

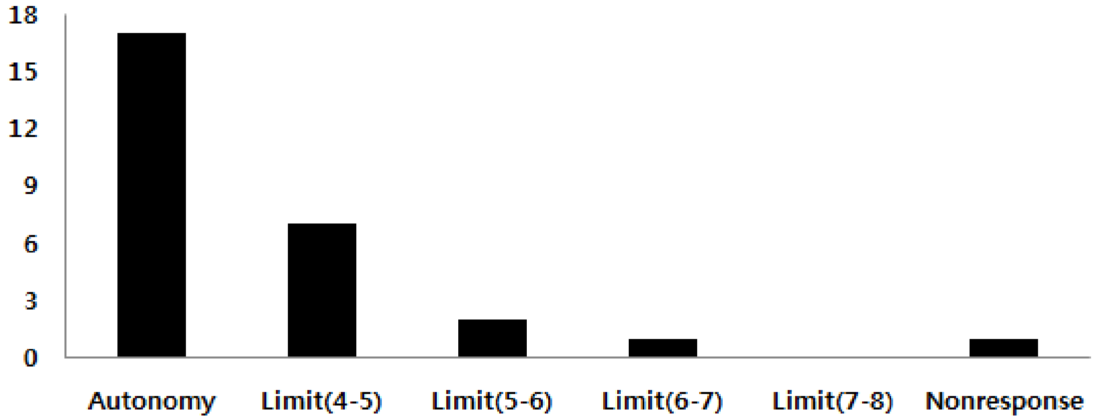


Figure 3. Roughage feed ration survey results.

Figure 4. Roughage production method survey results.

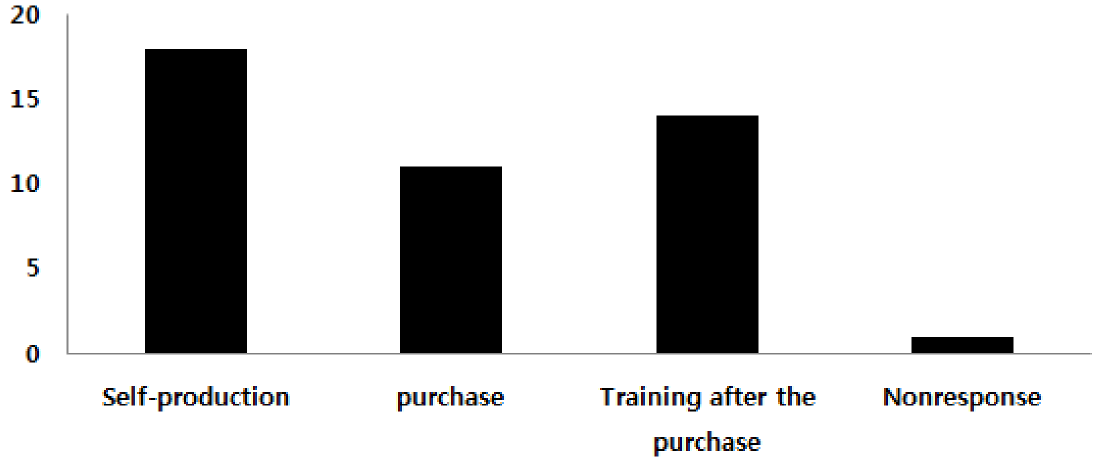


Figure 5. Riding horse supply method survey results.

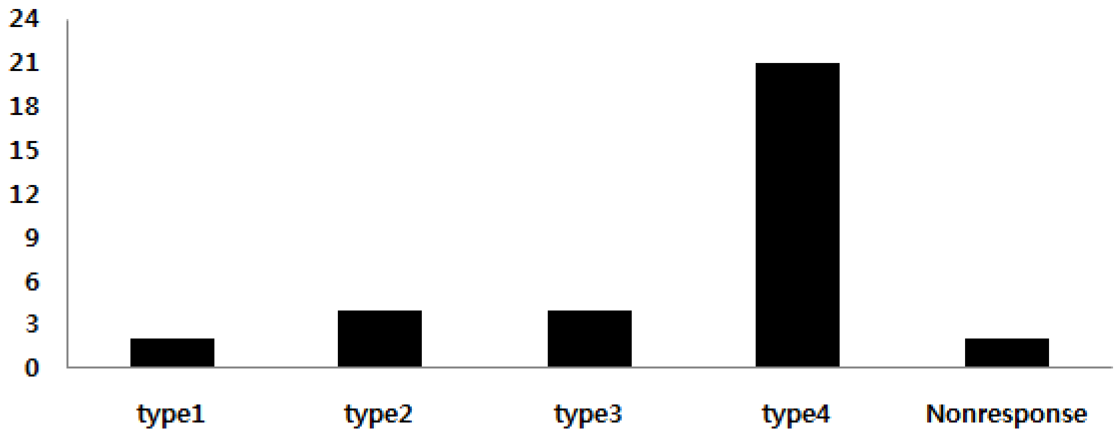


Figure 6. Preference riding horse body type survey results.

2. list of status of Jeju horse riding course

□ Songdang horse riding club(송당승마장)

○ Location: jeju-si gugwa-eup songdang-ri daehundong san 126 : go sang yeoun (제주시 구좌읍 송당리 대헌동 산12 : 고상윤)

○ Number of riding horse: 70

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
99,174 ㎡	16,528 ㎡	330 ㎡	165 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding		10 km	10	11,000

□ Jeju horse riding club(제주승마장)

○ Location: jeju-si chocheon-eup gyorae-ri 39-3 : jeong e nam (제주시 조천읍 교래리 39-3 : 정이남)

○ Number of riding horse: 64

○ Administrative type: Experience, Club, Member, School connection

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
195,867 ㎡	3,305 ㎡	99 ㎡	5,950 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	4	2 km		15,000

□ Alps horse riding club(알프스승마장)

○ Location: seogwipo-si pyoseon-myeon seseounglroad 73 : jeong huen

(서귀포시 표선면 서성일로 73 : 정 훈)

○ Number of riding horse: 78

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
330,578 ㎡	661 ㎡	661 ㎡	661 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	5	5 km		11,000

□ Pyeonghwa horse riding club(평화승마장)

○ Location: jeju-si hangyeong-myeon chengsuseo5road 53 : park chown bae

(제주시 한경면 청수서5길 53 : 박춘배)

○ Number of riding horse: 13

○ Administrative type: Experience, Coupon, Member,

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
7,272 ㎡	3,140 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3			50,000

□ Seokwang horse riding club(서광승마장)

○ Location: seogwipo-si andeok-myeon : han ae jung (서귀포시 안덕면 : 한애정)

○ Number of riding horse: 54

○ Administrative type: Experience, Club, Coupon, School connection

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3		5	9,000

□ C&P horse riding academy(C&P승마아카데미)

○ Location: seogwipo-si seongsan-eup samdal-ri 1767 : jeong su weon

(서귀포시 성산읍 삼달리 1767(대표 : 정수원)

○ Number of riding horse: 12

○ Administrative type: Coupon, Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
66,115 ㎡	1,652 ㎡	132 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Coupon horse riding	6	70 km		40,000

□ Dongbu leisure(동부레저)

○ Location: seogwipo-si pyoseon-myeon seong-eup-ri 2873 : hyeun dong boo

(서귀포시 표선면 성읍리 2873 : 현동부)

○ Number of riding horse: 80

○ Administrative type: Experience, Coupon

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	6	8 km		

□ Hueree horse riding club(휴애리승마장)

○ Location: seogwipo-si namwon-eup sillye-ri 2069 : yang ji sun

(서귀포시 남원읍 신례리 2069 : 양지선)

○ Number of riding horse: 7

○ Administrative type: Experience

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
1,652 ㎡	661 ㎡	66 ㎡	330 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding		300 m		40,000

□ Awooohlee horse riding club(아우오이승마장)

○ Location: jeju-si chocheon-eup waheul-ri san13 : nam hyeun

(제주시 조천읍 와흘리 산13(대표 : 남 현)

○ Number of riding horse: 17

○ Administrative type: Club, Experience, Coupon, Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
99,173 m²	5,289 m²			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding		2 km		20,000

□ ddalabi horse riding club(따라비승마장)

○ Location: seogwipo-si pyoseon-myeon gasi-ri 3149-33 : jeong eun young

(서귀포시 표선면 가시리 3149-33 : 정은영)

○ Number of riding horse: 14

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
85,500 m²	84,000 m²			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding		300 m	7-8	12,000

□ Leodo horse riding club(이어도승마장)

○ Location: seogwipo-si seongsan-eup susan-ri 2715 : kang gil ja

(서귀포시 성산읍 수산리 2715 : 강길자)

○ Number of riding horse: 33

○ Administrative type: Experience, Coupon

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
66,115 ㎡				

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding				

□ Joeun horse riding club(조은승마장)

○ Location: seogwipo-si andeok-myeon donggwang-ri 897-2 : cho geum dong

(서귀포시 안덕면 동광리 897-2 : 조금동)

○ Number of riding horse: 34

○ Administrative type: Experience

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
661,157 ㎡	3,305 ㎡	396 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding				

□ OK horse riding club(OK승마장)

○ Location: seogwipo-si pyoseon-myeon seong-eup-ri 3138 : her kyoung hwa

(서귀포시 표선면 성읍리 3138 : 허경화)

○ Number of riding horse: 60

○ Administrative type: Club, Experience, Coupon

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
9,917 ㎡	3,305 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3	40 km		20,000~120,000

□ Seungeup horse riding club(성읍승마장)

○ Location: seogwipo-si pyoseon-myeon seong-eup-ri 2045-1 : kim chun sik

(서귀포시 표선면 성읍리 2045-1 : 김춘식)

○ Number of riding horse: 58

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
66,115 ㎡				

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	5			

□ Island horse riding club(아일랜드승마장)

○ Location: seogwipo-si seongsan-eup nansan-ri 2236 : choi moon hye

(서귀포시 성산읍 난산리 2236 : 최문희)

○ Number of riding horse: 9

○ Administrative type: Experience, Coupon, School connection

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
16,528 ㎡				

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1		10	11,000

□ Woongji horse riding center (웅지승마센터)

○ Location: jejusi aewol-eup sanlokseoroad 81 : kim kyeong nam

(제주시 애월읍 산록서로 81 : 김경남)

○ Number of riding horse: 16

○ Administrative type: Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding				60,000

□ **Tourism horse riding club(관광승마장)**

○ Location: jeju-si chocheon-eup gyorae-ri san60-6 : seo mi suk

(제주시 조천읍 교래리 산60-6 : 서미숙)

○ Number of riding horse: 47

○ Administrative type: Experience, Coupon, Member, School connection

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
49,586 ㎡		6,611 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	4		30	50,000

□ **Mungae horse riding club (멍에승마장)**

○ Location: seogwipo-si seoseongro 397 : lim tae beum

(서귀포시 서성로 397 : 임태범)

○ Number of riding horse: 108

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
	991 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding				15,000

□ Woori horse riding club(우리승마장)

○ Location: seogwipo-si seongsan-eup samdal-ri 2254-9 : oh su jin

(서귀포시 성산읍 삼달리 2254-9 : 오수진)

○ Number of riding horse: 57

○ Administrative type: Experience, Coupon

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
33,057 ㎡				

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	4			

□ Iron and flowers horse riding club (쇠와꽃승마장)

○ Location: seogwipo-si seongsan-eup gosung-ri 345-1 : kim young jae

(서귀포시 성산읍 고성리 345-1 : 김용재)

○ Number of riding horse: 9

○ Administrative type: Experience, Member

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
2,400 ㎡	1,700 ㎡	20 ㎡	40 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3			

□ Sinpung horse riding club(신풍승마장)

○ Location: seogwipo-si seongsan-eup sinpung-ri 39-1 : go chang yeoun

(서귀포시 성산읍 신풍리 39-1 : 고창윤)

○ Number of riding horse: 23

○ Administrative type: Club, Experience, Coupon, Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
132,231 ㎡	66,115 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding		1 km		

□ Chowoun horse riding club (초원승마장)

○ Location: seogwipo-si sangye-dong 150 : park kyung hee

(서귀포시 상예동 150 : 박경희)

○ Number of riding horse: 43

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
165,289 ㎡	132,231 ㎡	264 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	2		15~30	

□ Eoseungsaeng horse riding club(어승생승마장)

○ Location: jeju-si nohyeong-dong 1100road 2659 : kang ki hyun

(제주시 노형동 1100로 2659 : 강기훈)

○ Number of riding horse: 60

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
165,289 ㎡	165,289 ㎡	132 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	6			100,000

□ Jeju top horse riding club (제주탑승마클럽)

○ Location: jeju-si bonggae-dong 275-66 : choo chang soo

(제주시 봉개동 275-66 : 추창수)

○ Number of riding horse: 25

○ Administrative type: Experience, Coupon, Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
82,644 ㎡	16,528 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3			

□ Seojin horse riding club(서진승마장)

○ Location: jeju-si chocheon-eup gyorae-ri san11 : kang kyung duk

(제주시 조천읍 교래리 산11(대표 : 강경덕)

○ Number of riding horse: 30

○ Administrative type: Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
115,702 ㎡		99 ㎡	132 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1			

□ Jeju horse support center(제주마지원센터)

○ Location: jeju-si nabeupnamroad 3road 169 : kim ki hyeun

(제주시 납읍남로 3길 169 : 김기현)

○ Number of riding horse: 36

○ Administrative type: Club, School connection

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
	800 ㎡		100 ㎡	

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	20 km		20,000

□ Leodosana Ltd. (㈜이어도사나)

○ Location: seogwipo-si pyoseon-myeon gasi-ri san41-3 : hong sun young

(서귀포시 표선면 가시리 산41-3 : 홍선영)

○ Number of riding horse: 10

○ Administrative type: Experience, School connection

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
85,500 ㎡	85,500 ㎡			

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	13 km	120	100,000

□ Pyeunghwa horse riding club(평화승마장)

○ Location: jeju-si hangyeong-myeon cheongsooseo 5road : lee jung soon

(제주시 한경면 청수서 5길 : 이정순)

○ Number of riding horse: 15

○ Administrative type: School connection, Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
8,372 ㎡	4,125 ㎡	99 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3	1~4 km	35~60	60,000~100,000

□ Jeju hall star(제주홀스타)

○ Location: jeju-si yeon-dong san146-18 : lee tae yeon

(제주시 연동 산146-18 : 이태연)

○ Number of riding horse: 25

○ Administrative type: Member, Experience

○ Register type: Farming and fishing village

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
10,000 ㎡	2,000 ㎡	99 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	2	6~8 km	60	60,000

□ Healing Farm(힐링 팜)

○ Location: jeju-si hallim-eup geumak-ri 253-1 : jeon young soon

(제주시 한림읍 금악리 253-1 : 전영순)

○ Number of riding horse: 4

○ Administrative type: Member

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
29,378 ㎡	2,080 ㎡	265 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	15 km	90	80,000

□ Raon derma park(라온 더마파크)

○ Location: jeju-si hallim-eup wollim 7road : son kwang sub

(제주시 한림읍 월림7길 155 : 손광섭)

○ Number of riding horse: 33

○ Administrative type: Member, Experience, Corporate training

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
202,142 ㎡	11,099 ㎡	14,502 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	500 m	30	30,000

□ Jeju horse riding park(제주승마공원)

○ Location: jeju-si aewol-eup yusuam-ri 1175 : seo myeong un

(제주시 애월읍 유수암리 1175 : 서명운)

○ Number of riding horse: 84

○ Administrative type: Member, Coupon, Experience, School connection, Corporate training

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
440,000 ㎡	1,300 ㎡	660 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	3	4~15 km	20~60	30,000~100,000

□ Tamra horse riding club(탐라승마장)

○ Location: jeju-si chocheon-eup gyorae-ri 42 : go young jo

(제주시 조천읍 교래리 42 : 고영조)

○ Number of riding horse: 24

○ Administrative type: Coupon, Experience

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
66,000 ㎡	49,780 ㎡	160 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	800 m	10~15	25,000

□ Cowboy horse riding club(카우보이승마장)

○ Location: jeju-si chocheon-eup waheul-ri 2201-7 : kim sun gi

(제주시 조천읍 와흘리 2201-7 : 김선기)

○ Number of riding horse: 15

○ Administrative type: Club

○ Register type: Physical training facilities

○ Import facility

Area	The outside grazing land	Horse affairs	Horse stable	Etc
	33,000 ㎡	330 ㎡		

○ Outdoor corse

Division	Number of Course	Distance	Time(min)	Price(₩)
Experience horse riding	1	4 km	25	60,000

3. list of Experimental animal of Jeju crossbred horses about conformation(No 1~25)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
1	4	Female	10	143	62	147	52	135	130	67	43	35	37
2	3	Female	6	150	57	144	53	138	134	64	42	38	35
3		Female	8	150	60	143	54	137	134	69	47	37	36
4	1	Female	6	140	51	132	45	133	129	65	48	35	35
5	1	Female	10	140	50	136	51	136	130	66	50	36	35
6		Female	10	138	50	134	53	129	124	61	47	31	33
7	4	Female	10	143	62	147	51	134	129	65	43	34	33
8	2	Female	12	134	52	127	47	132	123	60	45	34	34
9		Female	12	150	55	132	45	126	122	60	41	34	32
10	2	Female	7	147	63	134	42	131	126	68	43	34	34
11		Female	7	139	52	136	52	136	131	65	45	34	35
12	2	Female	14	129	53	129	49	126	123	63	43	31	31
13		Female	9	159	65	144	55	135	131	71	46	36	34
14	2	Female	12	135	59	127	47	116	115	57	35	28	28
15		Female	7	145	54	140	54	139	133	67	48	33	31
16	4	Female	11	141	67	144	47	131	128	66	42	34	30
17	1	male	8	143	52	136	53	137	132	61	40	35	34
18	3	Female	8	141	57	142	53	141	134	62	43	31	31
19	1	Female	9	131	53	134	51	136	129	63	43	33	33
20	1	Female	10	140	55	134	49	132	128	61	43	34	32
21		male	8	152	53	145	52	140	137	65	45	34	33
22	4	Female	9	142	67	144	54	136	131	68	45	33	33
23		Female	8	150	63	144	52	143	138	68	49	35	36
24	3	Female	7	140	57	143	51	141	136	67	42	36	35
25	3	Female	7	140	57	143	50	137	132	63	38	34	35

3. list of Experimental animal of Jeju crossbred horses about conformation(No 26~50)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
26	2	Female	8	140	60	134	49	134	128	63	41	32	31
27	3	Female	7	150	56	144	50	141	134	63	41	41	35
28		Female	8	146	55	151	51	144	141	62	47	35	34
29		Female	7	146	59	131	50	130	125	64	39	31	32
30		Female	6	144	50	139	48	137	130	62	43	32	33
31		Female	6	146	61	141	53	139	136	65	45	40	41
32		Female	7	143	54	143	53	143	135	65	41	35	39
33		Female	8	154	64	142	56	142	135	71	42	36	38
34	4	Female	7	143	69	149	56	143	136	68	39	33	36
35		Female	7	150	63	145	62	145	139	71	42	39	36
36		Female	7	155	70	139	52	139	132	70	38	37	37
37	3	Female	7	155	56	142	53	143	140	70	44	38	40
38		Female	7	150	55	146	60	144	139	69	40	37	38
39		Female	7	150	55	144	54	143	137	69	41	40	39
40	1	Female	7	143	54	134	57	141	129	64	43	35	36
41	1	male	4	141	54	131	55	132	125	66	37	36	34
42		Female	8	153	71	140	52	141	132	68	51	32	36
43	3	Female	7	145	56	141	52	144	136	69	44	33	36
44	3	male	4	147	57	143	50	140	133	62	41	34	42
45		Female	6	146	63	141	55	147	140	70	46	31	41
46		Female	7	149	55	142	53	130	133	70	46	33	38
47		Female	8	145	56	143	54	137	140	64	15	34	38
48		male	4	137	44	139	42	138	135	57	39	34	33
49	3	Female	9	153	57	141	50	139	132	63	40	36	35
50		Female	18	155	62	144	52	137	132	67	42	38	35

3. list of Experimental animal of Jeju crossbred horses about conformation(No 51~75)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
51	1	Female	9	135	52	134	47	130	124	61	42	36	33
52		Female	9	150	60	139	45	135	126	62	44	38	35
53		Female	6	153	65	139	51	136	129	64	44	36	32
54	4	Female	13	139	67	143	49	133	125	64	44	35	34
55		Female	12	151	54	138	49	131	126	60	44	35	33
56		Female	15	150	71	142	47	137	133	62	40	41	36
57	2	Female	14	150	62	134	46	131	123	58	42	33	34
58	4	Female	6	143	67	149	46	132	129	64	41	36	35
59		Female	14	158	77	147	48	142	136	71	48	41	35
60		Female	15	159	68	146	53	140	136	66	42	33	34
61	4	Female	18	143	67	149	45	144	136	66	48	36	38
62		Female	17	160	69	136	54	138	132	61	45	35	32
63		Female	13	142	65	138	48	136	130	63	50	33	33
64		Female	11	157	70	142	50	135	135	64	46	35	29
65		Female	25	147	56	134	55	134	131	64	47	34	32
66		Female	25	140	55	134	50	129	123	60	41	34	32
67		Female	25	138	68	140	54	138	135	67	42	34	32
68	4	Female	18	143	69	149	49	137	134	59	42	33	35
69		Female	12	133	56	135	47	133	128	65	45	33	31
70		Female	20	148	67	132	54	133	124	68	39	31	30
71		Female	7	167	57	146	58	141	137	65	48	36	37
72		Female	5	156	56	140	54	144	134	65	49	34	36
73		Female	15	166	64	143	66	144	138	66	46	36	34
74		Female	11	150	64	145	55	141	139	71	50	31	33
75		Female	8	160	57	148	61	147	139	67	47	37	36

3. list of Experimental animal of Jeju crossbred horses about conformation(No 76~94)

Number	Type	Gender	Old	Body length	Chest width	Withers height	Head length	Croup height	Chest girth	Chest depth	Croup length	cannon circumference	Hind circumference
76	1	Female	5	138	52	138	58	144	137	63	47	38	34
77		Female	14	155	65	134	52	130	123	60	38	33	32
78		Female	25	159	57	132	55	138	125	63	45	33	32
79	2	Female	20	129	51	128	56	130	121	59	44	33	33
80	2	Female	12	147	58	135	51	135	127	64	48	29	32
81		Female	5	152	62	139	51	134	128	62	44	35	31
82		Female	8	149	58	140	55	140	132	64	39	36	33
83		Female	5	140	51	139	52	137	130	58	43	34	35
84		Female	5	150	54	144	56	141	134	62	45	35	35
85		Female	18	147	58	139	51	142	130	60	48	34	31
86		Female	5	142	50	140	55	145	134	137	46	31	38
87	3	Female	7	141	56	142	54	142	135	67	43	32	33
88		Female	9	157	68	142	60	140	134	66	45	36	34
89	4	Female	12	140	67	143	54	144	134	66	46	33	35
90	1	Female	10	143	51	135	52	142	134	62	43	31	38
91	2	Female	8	143	64	125	46	126	120	59	43	31	33
92		Female	12	143	71	133	53	132	128	66	40	28	32
93	2	Female	20	134	54	126	51	138	129	64	46	31	34
94		Female	9	148	64	139	60	140	131	67	49	34	35

4. list of Experimental animal of Jeju crossbred horses of picture (No 1 ~ 6)

4. list of Experimental animal of Jeju crossbred horses of picture (No 7 ~ 12)

4. list of Experimental animal of Jeju crossbred horses of picture (No 13 ~ 18)

4. list of Experimental animal of Jeju crossbred horses of picture (No 19 ~ 24)



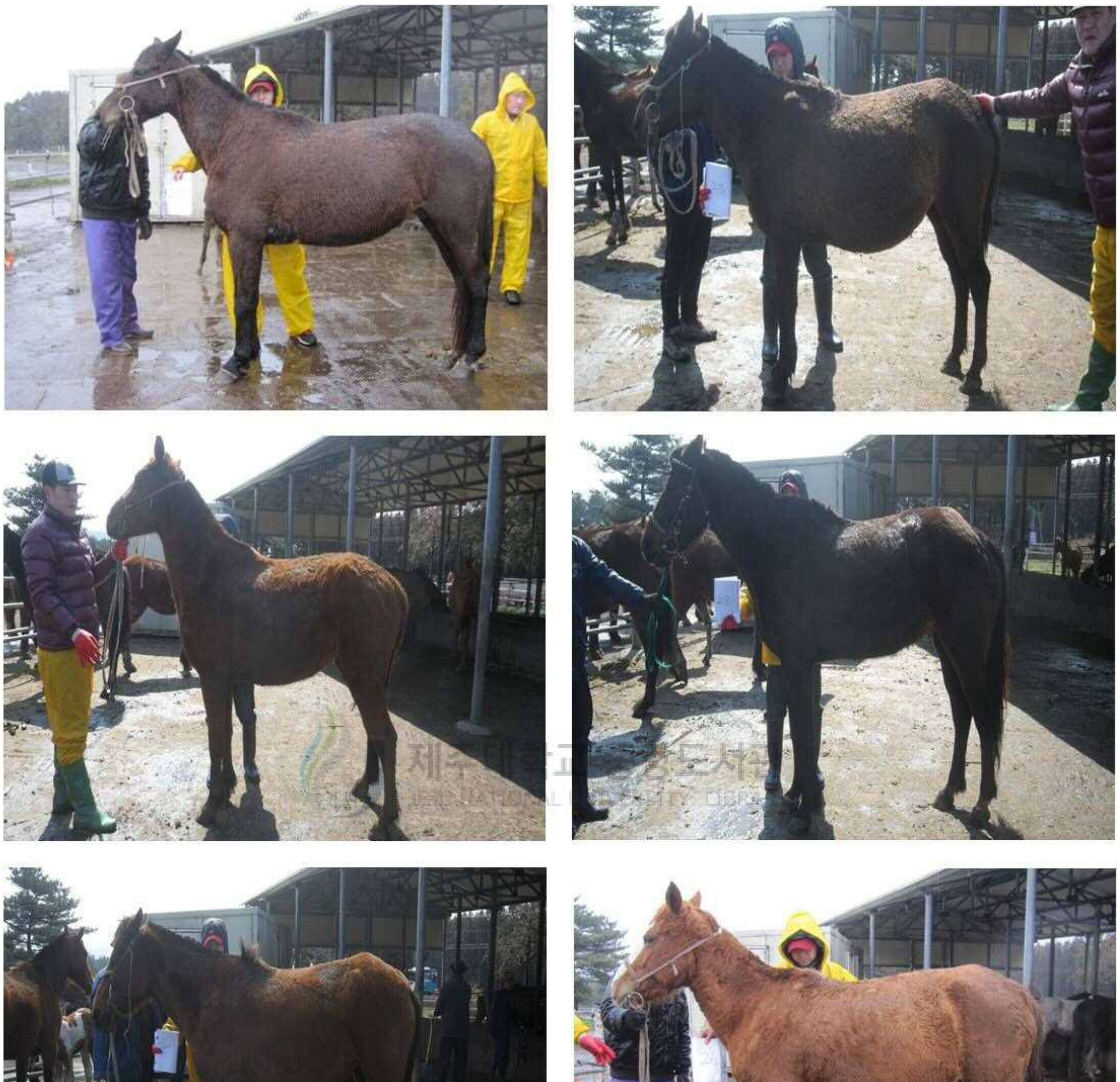



4. list of Experimental animal of Jeju crossbred horses of picture (No 25 ~ 30)






4. list of Experimental animal of Jeju crossbred horses of picture (No 31 ~ 36)

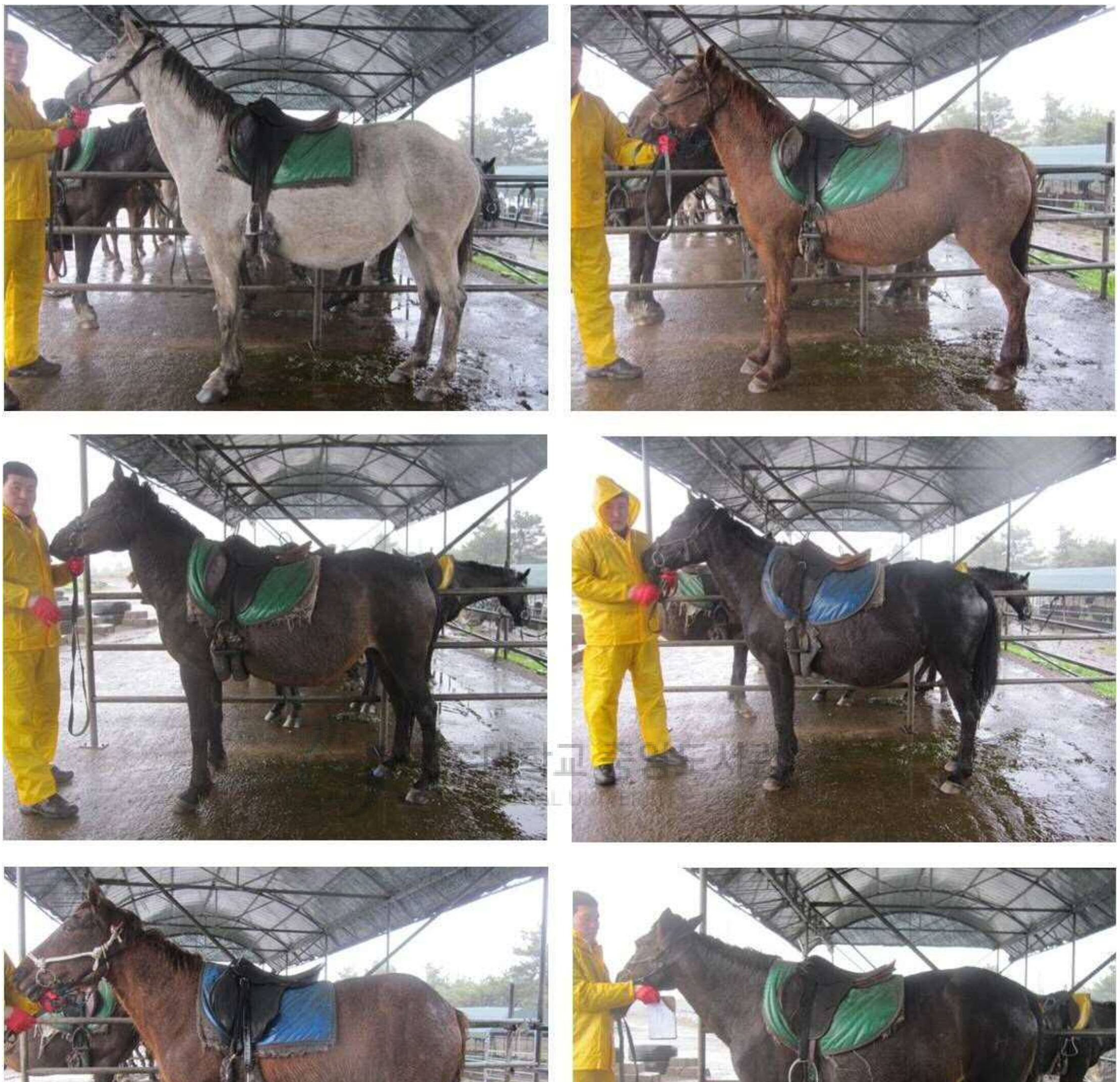


4. list of Experimental animal of Jeju crossbred horses of picture (No 37 ~ 42)






4. list of Experimental animal of Jeju crossbred horses of picture (No 43 ~ 48)



4. list of Experimental animal of Jeju crossbred horses of picture (No 49 ~ 54)

4. list of Experimental animal of Jeju crossbred horses of picture (No 55 ~ 60)






4. list of Experimental animal of Jeju crossbred horses of picture (No 61 ~ 66)






4. list of Experimental animal of Jeju crossbred horses of picture (No 67 ~ 72)

4. list of Experimental animal of Jeju crossbred horses of picture (No 73 ~ 78)






4. list of Experimental animal of Jeju crossbred horses of picture (No 79 ~ 84)






4. list of Experimental animal of Jeju crossbred horses of picture (No 85 ~ 90)

4. list of Experimental animal of Jeju crossbred horses of picture (No 91 ~ 94)




감사의 글

이제 비로소 모든 학위심사 과정을 마치고 논문의 마지막 마무리를 글로 남기려 하니 지난 일들이 스쳐 지나가면서 베풀지는 못하고 받기만 한 삶을 반성하게 됩니다. 저를 도와주신 분이 이렇게도 많음에도 불구하고 일일이 찾아뵙고 감사드리지 못하는 점 용서를 구합니다.

참으로 부족한 저를 학문의 길로 불러 들여 오늘의 제가 있게 해 주신 평생의 스승님이신 지도교수 강 민수 교수님의 은혜에 고개 숙여 깊이 감사드립니다. 바쁘신 가운데 초라한 논문을 맡아서 열과 성으로 심사해 주신 황 규계 교수님, 고 한종 교수님, 고 문석 박사님, 한 영준 박사님의 세심한 배려 덕분에 그나마 비로소 논문의 틀을 갖추게 되어 대단히 감사하게 생각합니다. 또한 대학원 생활 과정을 통해 제게 귀감이 되어주시고 늘 관심 있게 지켜봐 주신 양 영훈 교수님, 정 동기 교수님, 이 왕식 교수님, 오 성종 교수님의 은혜에 감사드립니다. 더불어 학과를 위해 온갖 잡무와 각종 자질구레한 일들을 군소리 하나 없이 처리하고 있는 한 경은 조교선생님, 황 순회 조교선생님, 김 광흔 조교선생님, 고 명신 조교선생님께도 감사드립니다.

이젠 눈빛만 봐도 속마음을 알 수 있을 정도로 동고동락 하며, 제 곁에서 언제나 엔돌핀이 되어 준 우리 발생공학실험실 식구들 배 재호, 박 준형, 박 석재, 오 명운 평생 동안 잊지 못할 것입니다. 그리고 학위논문 전문 기승자가 되어주신 강 옥득 박사님 바쁘다는 핑계로 언제나 맘속으로 찾아뵙고만 있어서 미안한 마음이 더 큽니다.

논문이 완성되어 가고 있는 과정에서 격려를 잊지 않으신 말산업대학원 김 덕문, 문 효숙, 김 성룡, 이 은정원우님께 깊은 감사드립니다. 그리고 대학원 생활 내내 힘이 되어준 후배들 고 경보, 강 동근, 김 성미, 김 정현, 임 도훈, 양 익동, 이 영화, 박 행철, 고 미정에게도 고맙고 감사드립니다.

제가 어린 시절부터 늘 사랑과 관심으로 내 인생의 든든한 후원자가 되어주신 아버지, 어머니의 희생과 사랑이 아니었으면 제가 이 자리에 없었을지도 모릅니다. 어려운 일을 헤쳐 나갈 수 있었던 것은 아버지, 어머니라는 이름이 존재했기 때문입니다. 그리고 언제나 정식적으로 든든한 후견인이 되어 주었던 큰 누나, 큰 매형, 작은 누나, 작은 매형 내외의 묵묵한 관심이 제겐 큰 힘이 되었고, 사랑스러운 어린 조카 준우, 현율, 서준, 뱃속에 있는 하율이 역시 제겐 큰 힘이 되었습니다.

항상 저의 건강과 안녕을 기원하고 기도해주신 할머니 감사합니다. 그리고 언제나 큰 용기와 응원을 보내주시는 작은 아버님들, 작은 어머님들, 사촌동생들 감사드립니다. 또한 지금 계셨다면 누구보다 기뻐해주시고 대견스러워 하셨을 할아버지의 사랑이 있었기에 모든 것이 가능 했습니다. 베풀어 주신 사랑 항상 기억하며, 그리워하며 가슴속 깊이 간직 하겠습니다.

장인어른과 장모님께는 죄송하다는 말씀과 감사하다는 말씀을 동시에 드리려 합니다. 지난 몇 년간 바쁘다는 핑계로 명절에도 잘 찾아뵙지 못한 점 죄송스럽게 생각하며, 또 그런 저를 언제나 환한 미소로 맞아주시며, 따뜻한 격려 아낌없이 해주신 은혜 평생 잊지 않겠습니다. 언제나 못난 형부를 세상에서 가장 멋있다고 응원해주는 하나밖에 없는 내 동생들 처남과 처제에게도 뭐라 감사의 말을 전해야 할지 모르겠습니다.

끝으로 참으로 셀 수조차 없는 긴 시간을 학업과 사업단 업무에 매달리느라 집을 비운 시간을 묵묵히 내조해 준 아내에게도 이 작은 기쁨을 바칩니다. 그리고 언제나 내 꿈의 언저리에서 맴도는 눈에 넣어도 아프지 않을, 사랑스런 내 인생의 보배 아들 권 윤후의 앞날에 아버지라는 이름의 작은 등불이 되길 간절한 마음으로 기원합니다.

2014년 12월
권 태 준