CHAPTER III

MATERIALS AND METHODS

This experimental research aimed to investigate the differences in foot pressure patterns and energy flow during the golf swing between professional and amateur golfers. The research involved the following steps:

1. Population and samplings
2. Data Collection Design
3. Data collection
4. Data Analysis

3.1 Population and samplings

3.1.1 Population

The population for this research was selected using purposive sampling. It consisted of right-handed golfers aged between 18-35 years, divided into two groups:

Group 1: Professional golfers (Pro)

Group 2: High handicap amateur golfers (handicap >15) (High)

3.1.2 Sample

Thirty golfers were divided into two groups based on their performance level: professional players and amateur players with a handicap higher than 15. These classes were named Pro and High, with 15 participants in each group.

Sample size determination using G*Power software. Following Cohen's (1988) recommendations, the effect size was set as large, medium, and small with values of 0.2, 0.5, and 0.8, respectively.

Given:

Effect size f = 0.8

β/α ratio = 1

Total sample size = 30

Group 1 size = 15

Group 2 size = 15

The resulting Power (1- β err prob) = 0.8607720

3.1.3 Sampling

Fifteen professional golfers and fifteen amateur golfers with handicaps exceeding 15 were categorized into two groups designated as "Pro" and "High" respectively.

3.1.3.1 Inclusion Criteria:

1. Professional golfers: Individuals who primarily play golf for income and have passed the qualification exam to become professional golfers.
2. Amateur golfers: Individuals who play golf for personal enjoyment and challenge.
3. Right-handed dominance in golf practice and competition.
4. Consistent practice of more than 3 times per week.
5. No history of severe injuries or surgeries in the core muscles, spine, wrists, elbows, shoulders, torso, knees, or ankles that would hinder participation in the research, within 6 months prior to joining the study.
6. Willingness to participate in the research.
7. All research participants can withdraw from the study immediately if they experience any potential risks to their health.

3.1.3.2 Exclusion Criteria:

1. Participants experience unforeseen events that prevent them from continuing in the research, such as injuries from accidents, illness, etc.
2. Participants no longer wish to participate in the study.

3.2 Instrumentation

1. One computer with 3D motion capture and analysis software.
2. Six Qualisys Camera Oqus (Oqus 7+ series, Qualisys AB, Sweden).
3. Visual 3D Motion Analysis software (C-Motion, Germantown, MD).
4. Two Kistler force platforms (Model 9286BA, Kistler Group, Switzerland).
5. One calibration set (wand and L frame) for defining reference coordinates in the research area (Qualisys AB, Sweden).
6. Retro-reflective markers (15 mm diameter) with flat bases (B&L Engineering, Tustin, CA, USA).
7. SuraSole Pro 8 sensor insoles (Surasole Pro 8, Suratec Co., Ltd., Nakhon Ratchasima, Thailand).
8. Documentation forms for recording experimental results

3.3 Construction and efficiency of the instrument

This research study analyzed the differences in pressure distribution on the sole of the foot and energy flow during a golf swing. The swing was recorded using video, and the recorded video was then transferred to a computer for playback and frame-by-frame analysis. The video was paused at specific points in the swing to capture still images for further data analysis.

3.3.1 Steps in designing data collection methods:

1. Study documents, principles, concepts, theories, documents, textbooks, articles, related research. and suggestions from experts and experienced people.

2. Determine methods for studying and analyzing differences in pressure distribution on the soles. and energy flow during the golf swing of golfers in the two sample groups.

3.3.2 Testing of research tools includes:

1. Testing reliability using the proposed data collection method. Thesis advisors will consider suitability and provide data collection methods to experts. Two people in the area of sports biomechanics performed the inspection. After that, the

revised data collection method was presented to the thesis advisor to apply the validated data collection method to the sample group.

2. Conduct a pilot study using data collection methods that have been passed. Check and then try to find the variable value of the distribution of pressure on the sole. and energy flow during the virtual golf swing studied in a sample group.

3.4 Data collection

3.4.1 Protection of research participants' rights

In this research, the researcher has protected the rights of the participants by obtaining permission from the Ethics Committee of Suranaree University of Technology (EC-67-152). The researcher has prepared informed consent forms for data collection, explaining the research objectives, and ensuring the confidentiality of the participants. The researcher will not disclose any individual information and will only analyze and present the data in aggregate form.

3.4.2 Equipment setup

1. Six sets of computer equipment with motion analysis software, recording devices, and 3D motion capture cameras. These are to be arranged to cover an analysis area of 6 x 6 x 8 meters. Marker position data and motion capture footage will be processed using Qualisys motion analysis software. Data synchronization will be implemented to ensure simultaneous data recording across all sources. The motion capture cameras will be connected to computers equipped with Visual 3D Motion Analysis software and configured to record at a frequency of 200 frames per second.

2. The cameras are positioned at a 45-degree angle in front of and behind the athlete. The image recording frequency is 200 Hz, and continuous recording is used with automatic light adjustment. The cameras are set up to cover the sample area and the golf swing cycle, along with the force plate, which records data at a frequency of 1,500 Hz. Both devices record data simultaneously (Synchronization).

3. Calibrate the accuracy of the motion analysis cameras by recording a 1-meter reference rod for 3 seconds. The calibration kit consists of a 300mm carbon fiber rod and an L-frame. After calibration, do not move or disturb the cameras from their original positions. Align the camera's coordinate system with the real-world

distances (Camera Calibration) using dynamic calibration. Set a reference point (0, 0, 0) to represent the X, Y, and Z positions of objects within the study area (Global Reference System). The X-axis points from left to right, the Y-axis points from back to front, and the Z-axis points from bottom to top. Then, record the motion by flashing a light towards all 6 motion analysis cameras simultaneously. The calibration process will be conducted on the day of equipment setup and before each participant's serving test, prior to data recording.

3.4.3 Basic data collection

1. On the day of basic data collection and golf swing testing, participants will receive documents explaining the details of the data collection process and instructions for proper practice. They will then be asked to sign a consent form to participate in the research.

2. Participants in the research will complete a basic information form. Additional notes recorded by the researcher include age, playing experience, and competition experience. After that, body measurements including weight and height will be taken.

3. After collecting the basic information, participants will wear 1.5-centimeter retro-reflective markers to identify the coordinates of various body joints based on physiological principles, using a standard skin marker set. Participants will wear shorts, skin-tight clothing, and sneakers without colored or reflective materials. The skin at the marker placement sites will be cleaned using an alcohol-moistened cotton swab before attaching the markers to the designated positions. The entire marker attachment process will take approximately 45 minutes.

4. Subjects performed a warm-up to familiarize themselves with the markers attached to their bodies and golf clubs. By being given time to become familiar with Test environment and as many locators as needed (Caroline et al., 2012).

5. Body Segment Model Parameter in this study, there were 15 body segments, consisting of 14 body segments, namely the head, torso, upper arms, distal arms, hands, upper legs, lower legs, and both feet. side and 1 part of the golf club. Attaching 42 fluorescent markers according to the body part and position on the golf club.

Table 3.1 All 42 location points.

Number	Marker	Location on the body
1	HeadFront	Forehead
2	HeadL, HeadR	Just above the ear center
3	LShoulderTop, RShoulderTop	On the outside of the elbow (bony prominence)
4	LElbowOut, RElbowOut	On the outside of the elbow (bony prominence)
5	LElbowIn, RElbowIn	On the inside of the elbow (bony prominence)
6	LWristIn, RWristIn	On the inside of the wrist (bony prominence on the thumb side)
7	LWristOut, RWristOut	On the outside of the wrist (bony prominence on the pinky side)
8	Chest	Upper part of the sternum
9	WaistLFront, WaistRFront	On the front of the pelvis (bony prominence)
10	LThighFrontLow, RThighFrontLow	Above the kneecap
11	LKneeOut, RKneeOut	On the outside of the knee (bony prominence)
12	LKneeIn, RKneeIn	On the inside of the knee (bony prominence)
13	LShinFrontHigh, RShinFrontHigh	Front of the shin
14	LAnkleOut, RAnkleOut	On the outside of the ankle
15	LForefoot5, RForefoot5	On the base of the fifth toe
16	LForefoot2, RForefoot2	On the base of the second toe
17	SpineThoracic2	On the 2nd prominence below the biggest prominence on the top of the spine
18	LArm, RArm	On the back of the upper arm
19	LHand2, RHand2	On the back of the hand at the base of the index finger
20	SpineThoracic12	A few cm below the midpoint of the lower tip of the shoulder blades
21	WaistBack	On the midpoint between the two prominences on the back of the pelvis
22	WaistL, WaistR	On the sides of the pelvis (bony prominence)
23	LHeelBack, RHeelBack	Back of the heel

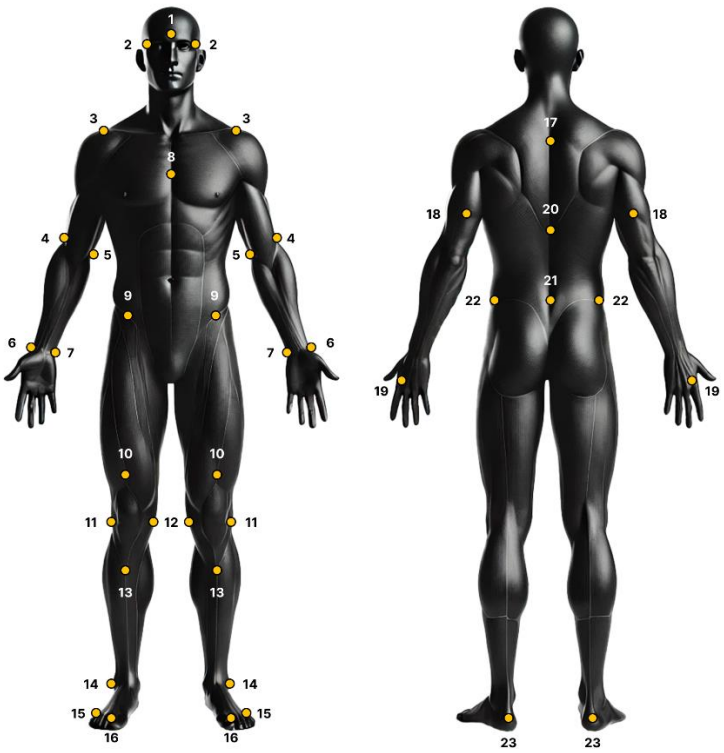

Figure 3.1 Color Atlas of Skeletal Landmark Definitions: Guidelines for Reproducible Manual and Virtual Palpations. (Jan and Van, 2007)

3.4.4 Golf swing test

The researcher explained the details and procedures for collecting data to the participants. The researcher and research assistant will attach reflective markers for marking points on various positions on the participants' bodies, totaling 42 positions (as shown in Table 3.1). Then, the researcher and research assistant will take the plates. The sensor insoles were for participants to wear inside their own shoes. Once the equipment was installed, the participants had to warm up for about 10 minutes to get used to the equipment attached to their bodies. Then it will be time to collect test data. The participants performed golf swings and movements similar to a real competition situation with each swing. To achieve the best total of 5 swings with each different golf club head. There is a 1 minute rest period after each swing and movement. When the participants completed the test, they were asked to stretch their muscles for at least 10 minutes after the test to relax the muscles after being used.

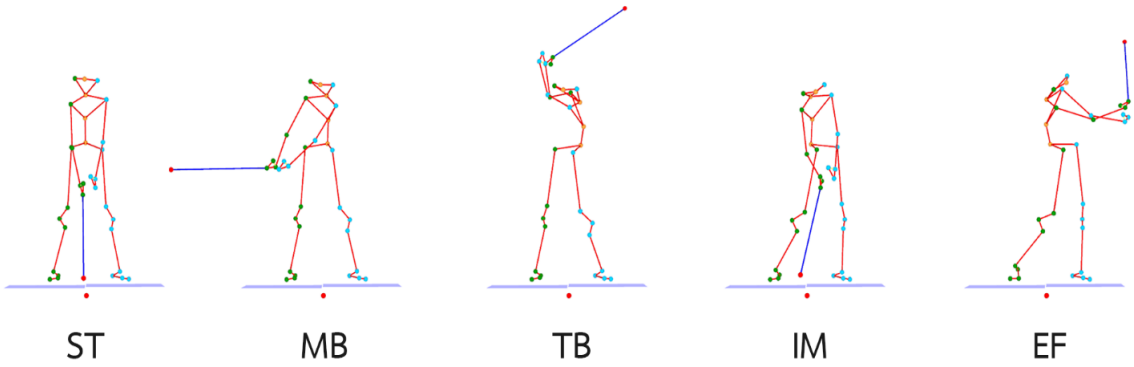

Figure 3.2 Key moments of the swing: Stand (ST), The golfer stands in position and ready to start the swing; Middle Backswing (MB), The club is moved backward and upward until the shaft is parallel to the ground; Top of backswing (TB), The club reaches its highest point in the backswing and starts to move downward; Ball Impact (IM), The clubface strikes the ball; Early finish (EF), The golfer continues the swing, with the shaft moving past the vertical axis.

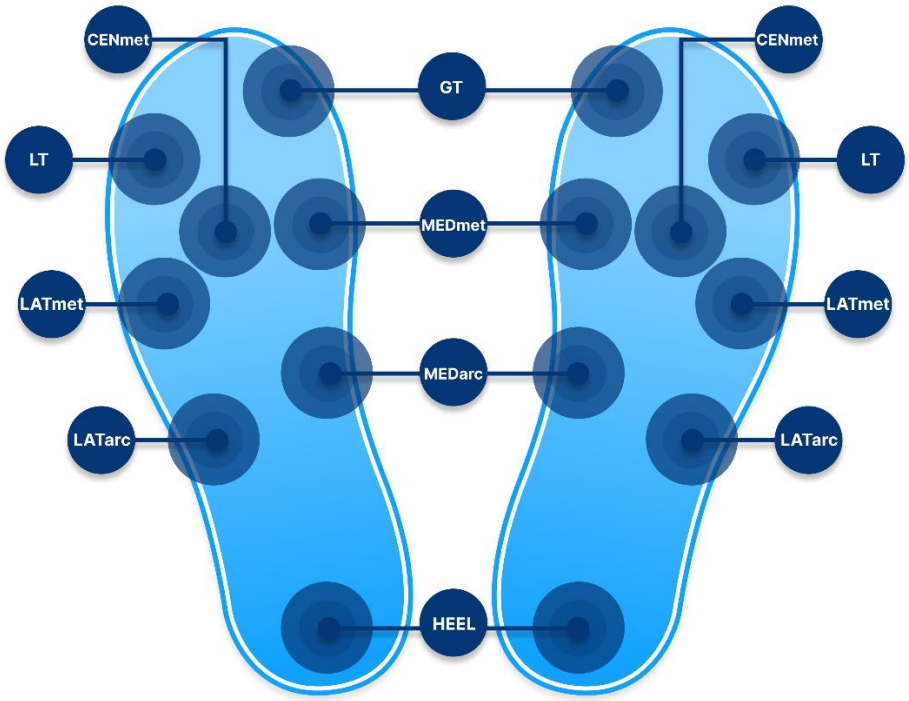

Figure 3.3 Eight Foot plantar areas defined for the statistical analysis: great toe (GT), lesser toe (LT), medial metatarsal (MEDmet), central metatarsal (CENmet), lateral metatarsal (LATmet), medial arc (MEDarc), lateral arc (LATarc), heel (HEEL).

3.4.5 Data analysis

1. The recorded images were analyzed for kinematic and kinetic data using a motion analysis program (Visual 3D Motion Analysis). The analysis was divided into five phases: Stand (ST), Middle Backswing (MB), Top of Backswing (TB), Ball Impact (IM), and Early Finish (EF). The image data were then imported into a computer to convert the recorded frames into marker positions over time (digitization), followed by processing to calculate linear velocity, angular velocity, and joint/body segment motion. In particular, for the kinetic data, Visual 3D's "Normalize using default normalization" option was employed, which automatically normalizes variables such as joint moments and joint powers by dividing them by the subject's body mass. This allows for meaningful comparison of biomechanical parameters across individuals with different body sizes.

2. Kinematic data analysis includes the analysis of force, resultant joint force, and joint torque, with calculations following the Cardan sequence (Z-X-Y) in flexion-extension, abduction-adduction, and internal-external rotation of body segments.

3. Analyze kinetic data to determine energy flow from the kinetic chain, including joint force power, segment torque power, joint torque power, and segment power during the golf swing between the two groups of subjects. Signal processing to manage noise will involve filtering with a Butterworth low-pass filter with a cutoff frequency of 6 Hertz.

4. Plantar pressure analysis was performed using data collected from smart insole sensors. Each foot had eight sensor positions, and the pressure values were initially recorded in kilopascals (kPa). These values were then converted into a percentage of total foot loading per foot. Specifically, the total pressure across all eight sensors on a given foot was normalized to 100%, and the pressure at each individual sensor location was expressed as a percentage of this total.

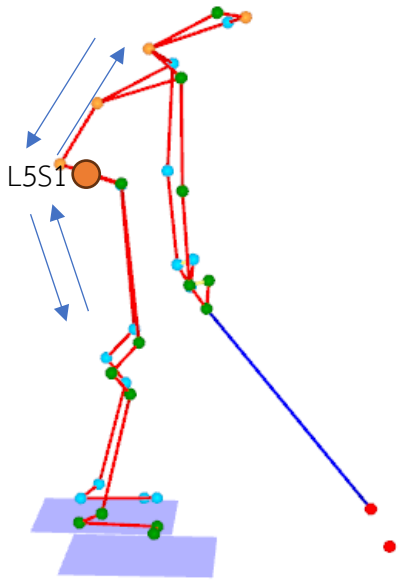

Figure 3.4 Illustrates the energy flow at the lumbosacral junction (L5S1), the connection point between the 5th lumbar vertebra (L5) and the 1st sacral vertebra (S1).

3.5 Statistics used to analyze data

This study aims to investigate foot pressure patterns and energy flow in the golf swing. The research process involves data collection and analysis using both kinematic and kinetic calculations. Statistical analysis was performed using SPSS 26.0 software (IBM Corporation, Somers, NY, USA).

1. Preliminary data analysis to understand the characteristics of the sample group and the distribution of variables used in the research by calculating basic statistics, including mean and standard deviation.

2. Comparison of foot pressure differences between different golf clubs within a group of professional golfers using Paired T-Test analysis.

2.1 Quantitative data measured on a ratio scale, from a single population.

2.2 Repeated measures taken twice: before and after.

2.3 Data distribution is normal, and data collection is randomized.

3. Compare the difference in foot pressure between the two sample groups using a T-Test analysis.

3.1 The data is measured on a ratio scale.

3.2 The data distribution is normal (Normal distribution).

3.3 The data is randomly sampled (Randomized data) from two independent populations.

3.4 The population variance is unknown, and the sample size is small.

4. Determine the relationship between foot pressure and energy flow values using Pearson Correlation Coefficient analysis.

4.1 Data must be quantitative.

4.2 The relationship must be linear.

4.3 Data should be normally distributed.