CHAPTER III

METHODS

Participants

Fifteen healthy elderly women participated in the study. They were recruited from Gerontology Groups in Chiang Mai community. All ambulatory, community-dwelling volunteers aged 60-75 years were screened for their eligibility to participate in the study. Each participant provided an informed, written consent. The study received ethical clearance from the Institutional Review Board of the Faculty of Associated Medical Sciences, Chiang Mai University.

Inclusion criteria:

- Comprehend instructions and willingness to participate in the study
- Age 60-75 years
- Able to walk independently without use of an assistive device
- A self-report of no history of fall in the previous 1 year

  Note: Fall was defined as an inadvertently coming to rest on the floor or another lower surface not as a result of syncope, seizure, stroke, or an excessive displacing forces (59).

Exclusion criteria:

- Musculoskeletal disorders or joint abnormalities that affected the ability to perform the test (e.g. severe edema, severe pain, ulcers, joint inflammation)
- Severe deformity (e.g. kyphosis, bow leg, knock knee)
- Neurological disorders (e.g. Parkinson's disease, stroke, brain injury, cerebellar disease, peripheral neuropathy, myopathy, active radiculopathy)

- Cardiovascular disorders (e.g. congestive heart failure, unstable angina)
- Chronic disease that could not be controlled (e.g. hypertension, DM, heart disease)
- Uncorrected visual impairment
- Use of medications that may affect balance (e.g. sedative, antidepressant)

Equipment

1. Personal data collection form
2. Digital video camera
3. Digital video cassette
4. Camera tripod
5. Spirit level
6. Silicon Coach 6.0 software program
7. Reflective markers
8. Harness
9. Treadmill; Biodex RTM Model 500 Numeric Display/Control Panel
10. Light bulb

Independent and dependent variables

Independent variables were 3 conditions of walking surfaces; level surface, upslope and downslope surface. Dependent variables were mean value of gait parameters (step length, double support time, toe clearance, maximal sole inclination) and gait variability (stride length variability, stride time variability).

Experimental setup

A treadmill was used to induce the three walking conditions: level surface (0° grades) upslope surface (ramped up 9° grade) and downslope surface (ramped down 9° grade). A 2-D Motion Analysis System was used to capture participants' lower extremity motions while walking. Two digital video cameras were placed in different position. One camera was located on the left side of the subjects to obtain a sagittal view, parallel to the floor and perpendicular to the plane of motion. This digital video camera was adjusted at a height 0.36 m above the ground and at a distance 2 m from the treadmill. In order to confirm for toe clearance position, another camera was located in front of the subjects to obtain a frontal view and parallel to the floor using a spirit level. This digital video camera was tilted down vertically 15°, located at a height 0.76 m above the ground and at a distance 1 m from the treadmill. Both digital video camera views were adjusted to obtain the subject's lower extremity. A light signal was used to synchronize a frame form both digital video cameras. A reliability of the 2-D setting was established prior to data collection.

Participant preparation

Eligible participants were informed about the purpose of the study and the testing procedures. Each participant read and signed an informed consent. Participants were interviewed for personal information then measured for height and weight. Participants were asked to wear pants and take off their shoes. Each participant was asked to walk at her self-determined pace on 6 m level ground for 3 times. Participants' preferred gait speed was calculated by average walking speed from the 3 trials and used to set as a treadmill speed during data collection. A self-determined

pace was chosen because, in healthy subjects, walking variability is minimized at this rate (60).

After obtaining the subject's preferred gait speed, the tester placed four reflective markers (2.8 cm diameter) on both feet. The reflective markers were bilaterally placed on anatomically, well-defined points of both feet. For the left foot, the reflective markers were placed on the lateral side of the calcaneum and the tip of the longest toe. For the right foot, the reflective markers were placed on the medial side of the calcaneum and the hallux. Participants were asked to stand on the treadmill belt and supported by an individually fit instrument safety harness that was adjusted appropriately for each subject to protect them from falling but not restrict their movements.

Protocols

There were three walking conditions. The sequence of each condition was randomized.

Condition 1: Walk on the treadmill on level surface (0° grade)

Condition 2: Walk on the treadmill on upslope surface (ramped up 9° grade)

Condition 3: Walk on the treadmill on downslope surface (ramped down 9° grade)

Note: Legislated standards and recommendations for the construction of walkways (61-62) specify that maximum slopes are ranging anywhere from 3° to 9°

Prior to data collection, 1 practice trials were given for a minimal of 15 min (63) to allow subjects to be acquainted with the treadmill. In this familiarized periods, the tester gradually increased the speed until each participant's preferred speed was

reached. The testing began when the subjects felt comfortable to the test protocol. Participants were asked to rest about 5 min after the practice trial.

Each testing condition required the participant to walk 10 min on the treadmill without handrails use (64). Participants were instructed to look straight ahead during testing. Time rests for each inter-condition was about 5 min or as subject needed. During data collection, one tester stood besides the subject to provide support if a loss of balance occurs.

Data reduction

All video images of the successful walking trials were imported to a computer installed with a SiliconCoach 6.0 program (SiliconCoach Ltd., Dunedin, New Zealand). Video images were captured and digitized to obtain the x-y coordinates for each reflective marker using a SiliconCoach 6.0 program with a sampling rate at 50 frames per second. The video image in each walking condition was digitized separately in each minute (min1, min2,...., min10). Each image frame provided approximately 40-50 strides per minute. Data from minute 1 to 2 and 8 to 10 of each condition were removed to minimize the starting and ending effects (23). All digitized frames were transferred to ratio scale for calculation using Microsoft excel. Information on the intra-rater reliability of the mean gait parameters used in the present study is shown in Appendix D.

For each stride, six dependent parameters were calculated: step length, double support time, toe clearance, sole inclination, stride length variability and stride time variability. Each dependent variable was determined using the following criteria.

Gait parameters

Step length was defined as the distance (in meter) between the left heel to the right heel when one limb initially contacts on the ground.

Double support time was defined as the duration (% of gait cycle) over which heel contact of one limb and toe off of the contralateral limb occurs.

The position of heel contact was determined as the point where the marker placed on the lateral/medial side of the calcaneum initiates contact on the ground. The position of toe off was determined as the point where the reflective marker placed on the tip of the longest toe contacts on the ground prior to lift off (i.e. the end point of stance phase).

Toe clearance was defined as the maximal height (in centimeter) of toe elevates from the floor at mid swing phase.

The position of maximal toe clearance was determined as the point where the reflective marker placed on the tip of the longest toe at mid swing phase just prior to terminal swing phase. The toe clearance height was measured from this point relative to the position at mid stance phase.

Sole inclination was defined as the maximal angle (in degree) of the left foot at heel contact relative to its horizontal line.

Gait variability

Stride length was defined as the distance (in meter) between successive heel contact of the same foot (stride length was calculated from two consecutive step length)

Stride time was defined as the duration (in seconds) over which one stride occurs

The mean stride length and stride time was calculated for each walking condition. The coefficient of variation (COV) was used to quantify the variability of stride length and stride time. The COV for each gait variability parameter was determined by the following equation:

$$COV = (SD/mean) \times 100\%$$

The COV was quantified the magnitude of variability in stride length and stride time with respect to each participant's mean value (25, 65).

Statistical analysis

Data of all variables in each condition were tested for normality, using one-sample Kolmogorov-Smirnov test. The results revealed that all data had normal distribution. Repeated measures ANOVA was used to compare gait parameters and variability among the three surface conditions (level, upslope and downslope surface). Post hoc analysis was conducted to identify the location of the differences. A probability level of 0.05 was set to denote significance.