CHAPTER III

METHODS

Participants

Ten obese and ten normal weight women, aged 41 to 58 years, were recruited for the study. The characteristics of the participant presented in Table 2. The obese group was recruited from individuals whose BMI greater than 25.0 kg/m^2. Mean BMI of obese group was 32.78 ± 4.52 (range 28.10-43.28 kg/m^2). The normal weight group was recruited from individuals whose BMI of 18.5 to 22.9 kg/m^2. Mean BMI of normal weight group was 20.93 ± 1.29 (range 18.79-22.29 kg/m^2). Ten normal weight women were age- and height-matched with the ten obese individuals. All participants were able to walk on treadmill and overground without the use of assistive device. Participants were instructed not to have a meal or caffeine beverage 2 hours before testing and alcohol beverage 24 hours before testing. The participants were excluded from the study if they had diagnosed with neurological disorders or cardiovascular disorders (such as brain injury, stroke, congestive heart failure) and musculoskeletal disorders or any injuries to the lower extremities that could affect their walking ability (such as ankle sprain, osteoarthritis, severe pain).

Table 2 The characteristics of participants

Characteristic	Normal weight group	Obese group	*p* value
Age (years)	47.70 ± 4.42	51.20 ± 7.27	0.076
Height (cm)	157.90 ± 4.31	154.60 ± 6.06	0.253
Weight (kg)	52.15 ± 3.12	78.65 ± 13.46	0.001 *
BMI (kg/m^2)	20.93 ± 1.29	32.78 ± 4.52	0.037 *
Velocity (m/s)			
• Overground	1.21 ± 0.11	1.07 ± 0.20	0.138
• Treadmill	1.21 ± 0.11	1.08 ± 0.21	0.090

* Significant difference at $p < 0.05$, obese group VS. normal weight group

Information about participants' occupational physical activities were concluded from a physical activity questionnaire. The questionnaire was used in the European Prospective Investigation into Cancer and Nutrition (EPIC) study. For obese groups, there were 4, 3, and 3 participants having sedentary occupation, standing occupation and physical work, respectively. In normal weight groups, the number of sedentary occupation, standing occupation and physical work were reported for 6, 2, and 2 participants. None of participants involved in heavy manual work.

Table 3 Types of occupational physical activity for obese and normal weight participants

Type of occupational physical activity	Number of subjects	
	Normal weight groups	Obese groups
Sedentary occupation	6	4
Standing occupation	2	3
Physical work	2	3
Heavy manual work	-	-

Equipment

1. Digital video camera
2. Series 2000 Treadmill (Marquette GE Medical System, USA)
3. Stop watch
4. Circular markers
5. Wooden stick (length 1 meter)
6. Measuring tape
7. Athletic shoes
8. Dark colored sleeveless shirt, tight shorts
9. Helthometer Model 503KL
10. Water gauge level

Independent and dependent variables

Independent variables included group of participants (obese and normal weight groups) and walking mode (overground at comfortable speed, treadmill at comfortable speed with 0% grade, and treadmill at comfortable speed with 10% grade). Dependent variables were selected temporospatial variables and lower limb joint.

Experimental setup

A digital video camera was located approximately 90º to the plane of motion to obtain the sagittal view of the participants, at a height of 0.80 meters above the ground, and at a distance about 4 meters from a walkway or a treadmill depending on the walking mode. Treadmill walking trials were performed on a motorized treadmill equipped with handrails at both sides. The treadmill belt speed was calibrated before data collection. Different displayed speeds (range from 1.5 to 2.5 km/h) were compared with calculated speeds, by measuring the time taken for the belt to complete five revolutions.

Participant preparation

Height and weight of each participant were measured. Prior to the walking trials, each participant answered a health and physical activity questionnaire. The participant was asked to change to wear provides dark colored sleeveless short, tight shorts and athletic shoes. Seven markers were attached on the left side of the participant at the following anatomical landmarks: acromial process, anterior superior iliac spine

(ASIS), midpoint of greater trochanter, lateral femoral condyle, lateral malleolus, head of fifth metatarsal and heel. One additional marker was attached on the right heel.

Protocols

Overground walking trials

Each participant was asked to walk along a 6-meter walkway at her self-selected speed for 3 times. Walking speed was calculated for each trial. Each participant's average walking speed from the three trials of overground walking was used to set as preferred walking speed for subsequent treadmill walking trials.

Treadmill walking trials

Participants were given a minimal of 15 minutes to become familiar with treadmill walking at their preferred walking speed until they were able to walk comfortably. Participants were able to rest during treadmill familiarization. There are two modes of treadmill walking: 0% grade mode and 10% grade mode. Participants were tested at the 0% grade first followed by the 10% grade. Treadmill walking trials were collected for 30-second for each walking mode. Three gait cycles were later selected for data analysis.

Data reduction

Video images were captured for the selected gait trials using a SiliconCoach program version 6.0. One complete gait cycle was determined as the first point contact of

left heel to the second point contact of left heel. Then, a SiliconCoach version 6.0 Program was used to provide single-frame viewing on the surface of a computer monitor in order to obtain the x-y coordinates for each marker for all image frames. Smoothing of the 2-D coordinates for reduction of digitization noise was done using an algorithm on a PSI-plot program (Poly Software International, New York, USA). Calculation of all variables was done using Microsoft excel. Information on intrarater reliability regarding derivation of the kinematic variables is shown in Appendix C.

Joint angular displacement for each walking mode was determined by averaging joint angle data from the three gait cycles. Joint angles were calculated from the relationship between adjacent segments of the body. Figure 3 showed the defined joint angles (20).

- Trunk angle was calculated as the angles subtended at the vertical lined and the line representing trunk segment, i.e., from acromial process to greater trochanter.
- Hip angle was calculated as the angle subtended at the vertical lined and the line representing hip segment, i.e., from greater trochanter to lateral femoral condyle.
- Knee angle was calculated as the angle subtended at the knee by the line representing hip segment, i.e., from greater trochanter to lateral femoral condyle and the line representing shank segment, i.e., from lateral femoral condyle to lateral malleolus.
- Ankle angle was calculated as the angle subtended at the ankle by the line representing shank segment, i.e., from lateral femoral condyle to lateral malleolus and the line representing foot segment, i.e., from lateral malleolus to head of fifth metatarsal.

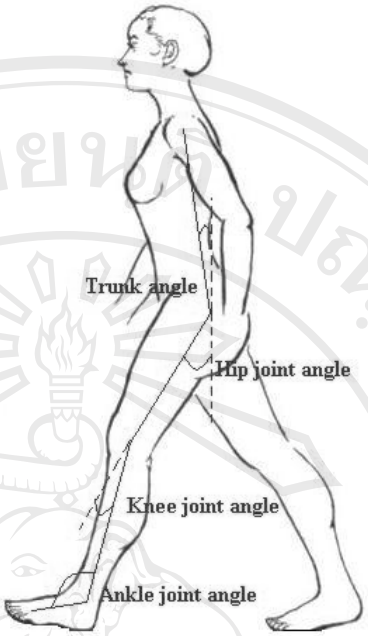

Figure 3 Diagram for calculation of trunk, hip, knee, and ankle joint angle.

(Modified from Ref. No. 20)

Step length was defined as the distance between the left heel to the right heel when both feet are in contact the ground. Cadence was calculated by number of steps per minute. Stance time was period when the left foot is in contact with the floor. Swing time was period when the left foot is in the air. Figure 4 demonstrates the measurement of step length (21).

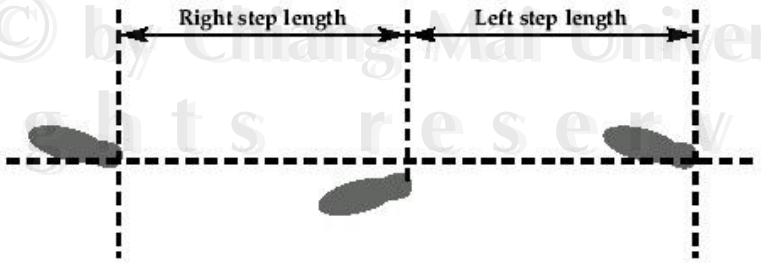

Figure 4 Step length. (Modified from Ref. No. 21)

Statistical analysis

The Spapiro-Wilk test for normality revealed that the data of all variables had normal distribution. Therefore, parametric statistic was used to compare temporospatial variables and joint displacements between groups and modes of walking.

Independent sample t-test was used to compare the differences of the temporospatial variables and joint kinematic displacements between the obese and normal weight groups. A one-way repeated measure ANOVA was used to compare between modes of walking. All statistical analysis was undertaken using SPSS software program (version 11.5). A significance level of 0.05 was used in all tests of significance.