CHAPTER 5

DISCUSSION

The purpose of this study was to investigate the impact of footwear styles on postural control ability of Thai elderly women. Based on our knowledge, there has not been any report on which footwear styles that are most commonly worn by Thai elderly women. Thus, in the first part of the study, a survey study was conducted to find out what are the top 3 footwear styles that mostly worn by elderly women. Since life style and socioeconomic status can influence the choice of footwear selection, the scope of the survey was limited to those who reside outside the municipal area. The 3 most popular footwear styles obtained from the survey were then used in the second part of the study. In this part, the postural control ability of each elderly woman while wearing these 3 footwear styles and the athletic footwear was evaluated. The athletic footwear was included to serve as the gold standard footwear. It has been recommended in the literature that the athletic footwear provides best postural control ability when compared to other footwear styles (13, 14).

1. Part I: the Survey Study

The survey study was aimed to identify the top three footwear styles that most commonly worn by Thai elderly women who live outside the municipal area in Chiang Mai province. The survey outcomes confirmed our hypothesis that the

popular footwear styles that most Thai elderly women wear will be different from those reported in the United States (13). In the present study, the top three footwear styles chosen by the participants were sandal (45.3%), thong (28.8%), and high-heel shoes (12.4%). In contrast to Koepsell and colleagues (13) who found that the most common footwear styles worn by elderly men and women in Washington State, United States were athletic and canvas shoes (sneakers). Unlike previous reports, none of the participants in the present study rated the athletic shoes as the type of shoes they often wear daily and only 4.1% of the participants rated the canvas shoes (sneakers) as the footwear style they often wear. Findings from the present study were not unexpected. Several factors are known to influence how people choose to wear an outfit and footwear style. These factors include environment, culture, life style, and socioeconomic status. In the western countries where the weather is cold, people often wear socks and footwear styles that cover all parts of the feet such as walking shoes, athletic shoes and boot whereas in the eastern countries where the weather is warm and humid, people often wear footwear styles that do not cover the whole feet such as sandal and thong. For the cultural perspective, people in Thailand and neighboring countries often take off their shoes when enter the house, temple or building. This may also be one of the reasons while the preferred choices of footwear were those that can put in and take off easily such as sandal and thong. Last but not least, the socioeconomic status also influences the style of footwear that people choose. People whose their socioeconomic status are in the middle or upper class often wear dressed shoes or formal footwear styles while people in the relatively

lower class tend to wear casual footwear styles. We speculate that the findings will be different if the survey was done in elderly women who live in the municipal area.

2. Part II: the Experimental Study

The second part of this study compared postural control ability when each elderly woman wore the top three footwear styles obtained from the survey study and the athletic shoes. In the present study, the OLST, Reach test, modified CTSIB, TMW, and TUG were used to reflect the postural control ability. The reason that these tests were chosen is based on the knowledge that postural control involves the complex interactions of several systems. Therefore, only one single balance assessment is unable to give comprehensive information on a person's postural control ability. Each test in the present study assesses different aspect of postural control. For example, the OLST assesses a person's anticipatory postural adjustment of weight shift from two-leg to one-leg stance and the postural steadiness in a static position (44). The functional and lateral reach tests assess a person's limit of stability in the anterior and lateral directions (48). Overall, the participants demonstrated comparable postural control abilities for all four footwear styles in most of the postural control tests except for the modified CTSIB on foam surface with eye closed condition and the TUG test.

3. The impact of features of each footwear style on postural control ability

3.1 Thong

Previous studies (14, 18, 19, 50) suggested that good features of proper shoes include large sole and surface contact area, heel collar, medium to hard sole hardness,

bevelled heel, and flared sole. Among these shoe features, thong has large sole and surface contact area. The advantage of having large surface contact area at sole shoes is that it allows weight bearing and ground reactive force to spread over a larger region, resulted in enhancing somatosensory feedback from the sole of foot. In addition, the large sole provides broad base of support which increases the stance and gait stability (14). The thong is light in weight and its sole is soft. Previous study suggested that soft sole has a detrimental effect on joint position sense in the aspect of poor mechanical support of feet (18). Several studies (18, 19, 50) reported that soft soles shoes provoked instability during walking in elderly people, especially increased risk of slipping on wet surface. Therefore, thong should not be recommended to elderly people. Our findings, however, did not find differences of postural control abilities in all tests when participants wore thong compared to when they wore sandal, high-heel, or athletics shoes. We speculate that the large surface contact area together with light weight and low heel height are the thong's features that may account for the non significant findings between thong and other footwear styles. Detrimental effect of thong may be observed if the tests that involve walking such as TMW and TUG tests were performed on a slippery surface.

Although the maximum distance that the participants could reach during the FRT and lateral reach test were not different across footwear styles, the mean values showed that they could reach farthest when they wore thong. Reach tests were designed to assess a person's limit of stability (59, 60). Thus, wearing thong may enhance the participants' limit of stability.

3.2 Sandal

Similar to thong, sandal has relatively large sole and surface contact area but sandal has harder sole hardness and greater weight than thong. Menant and colleagues (19) found that shoes with medium and hard sole hardness provide optimal stability on level, irregular, dry and wet surfaces. The authors explained that hard sole hardness increases tactile sensory input to the mechanoreceptors of the sole of foot for controlling balance, and reducing sway in elderly people (50). Thus, the medium and hard sole shoes provide better stability than soft sole shoes (18, 19, 50). In the present study, sandal was rated by the elderly participants as the choice of footwear style they wear most often in daily living (45.3%). Findings revealed that overall, participants showed similar performance in almost all postural control tests when they wore sandal compared to other footwear styles except for the standing time on foam surface with eye closed condition that was significantly shorter compared to when they wore athletic shoes (p= .02). One possible explanation is that when compared to athletic shoes, sandal did not have heel collar. The main role of heel collar feature is to promote tactile cues by facilitating joint position sense that resulted in improving proprioceptive feedback of ankle joint position (14).

3.3 High-heel shoes

Narrow flared sole and surface contact area together with high-heel are unique features of high-heel shoes. The foot position is placed in plantarflexion (63). Therefore, the position of the total body center of mass was raised and shifted forward, resulted in increasing risk of fall (19). Our findings revealed that elderly participants took significant longer time to complete the TUG test when they wore

high-heel shoes as compared to athletic shoes (p= .40). In addition, the standing time on foam surface with eye closed condition was shorter when they wore high-heel compared to athletic shoes. However, Bonferroni comparison only approached significant (p = .05). It should be noted that all participants in the present study did not take longer than 14 seconds to complete the TUG regardless of the footwear styles, suggesting no risk of fall while wearing any of these footwear styles (71). The detrimental effects of high-heel shoes on TUG scores were consistent with findings from previous studies. For example, Arnadottir and colleagues (48) investigated whether footwear affected performance on TUG test in elderly women. They found that elders took longer time to complete TUG test when they wore dress shoes with heel height 5.3±1.2 cm (14.02±6.73 sec) compared to walking shoes (i.e. athletic shoes or oxford-type shoes) (12.82±6.45 sec). The average time to complete TUG test in the present study was, however, shorter than that in Arnadottir's study due to the differences in participants' age between the two studies (80±6.48 yrs compared to 63.23±3.22 yrs in the present study) and the heel-height used (5.3 cm compared to 3.7 cm in the present study). Several studies revealed that high-heel shoes affected postural control and temporo-spatial gait variables in elderly people. Specifically, high-heel shoes led to increase in postural sway, double-support time, and toe clearance, and reduce in walking velocity when compared to standard oxford-type shoes (19, 50).

The detrimental effect of high-heel shoes on postural control abilities were expected to be more pronounced than what the results actually revealed. Several factors may account for less detrimental effects of high-heel shoes in the present

study. First the features between the high-heel shoes and sandal were only slightly differences (Table 4). The narrow flared sole and surface contact area are supposed to be unique features of high-heel shoes. However, in the present study the sole width of the high-heel (8.0 cm) was only slightly narrower than that of the sandal (8.3 cm). Second, the foot position was only placed in slight plantarflexion (approximately 24 degree). Thus, the instability induced from the raised and shifted forward of center of mass was minimum. In addition, several participants reported that they wear high-heels daily. Acquaintance with high-heel shoes may be another factor that lessens the detrimental effect of high-heel shoes.

3.4 Athletic shoes

Among the 4 footwear styles, athletic shoes contain all features that have been documented as the key features beneficial for enhancing postural stability (14). In the present study, although the beneficial effects of athletic shoes in enhancing postural control were not outstanding when compared to other footwear styles, our findings confirmed the notion that athletic shoes provide superior postural control abilities especially when compared to high-heel shoes. Participants received the best TUG score when they wore athletic shoes and the worst score when they wore high-heel shoes. Timed Up and Go test measured the time taken for an individual to stand up, walk for 3 meters, turn around, then walk back and sit down (70). Several features of the athletic shoes explain why participants took the shortest time to complete TUG. First, the tread pattern at sole shoes of the athletic shoes which increases coefficient of friction and reduces shear forces at shoes sole-floor interface may improve propulsion efficiency (18, 19). Second, the relatively hard sole hardness of the athletic shoes has

shown to improve walking stability (18, 19, 50). Together, participants could walk and turn efficiently when they wore athletic shoes. I n addition, the high heel-collar which provides stability at gait termination (52) may be another feature that ensures stability to stop or changing direction (i.e. turn) during walking without having to slow down as much. Finally, the ability to stand up or sit down quickly during TUG may be encouraged by the large sole and surface contact area of the athletic shoes which known to improve medial-lateral stability by increasing BOS (14).

The standing time on foam surface with eye closed was also significant longer when they wore athletic shoes compared to sandal and approaching significant compared to high-heel. It is speculated that the large sole and surface contact area together with the heel-collar of the athletic shoes account for this finding. Specifically, the large sole and surface contact area which improve participants' medial-lateral stability may result in an increase in the standing time on foam surface. The heel-collar which limits the supination movement around the subtalar joint may also help improve lateral stability. In addition, previous studies reported that heel-collar improves proprioceptive feedback of ankle position by providing tactile cues that facilitate joint position sense (14, 18, 19). Together, these features of the athletic shoes benefit the participants' standing performance on foam surface with eyes closed. Although mCTSIB were examined in several studies, it is difficult to compare mCTSIB scores across studies, including the present one, due to the differences in research methodology. For example, Murphy and colleagues (74) reported the mean scores of 24.2±9.2 for non-faller elders and 13.7±14.1 for faller elders on mCTSIB on foam surface with eye closed. Their participants were, however, much older (mean

age ~ 75 years) than that in the present study. Contrary to the present study, the participants were tested barefoot. Thus, effects of footwear on mCTSIB scores were eliminated in their study.

For TMW test, participants walk fastest while wearing athletic shoes. However, statistical analysis revealed no significant differences among the four footwear styles. Gait velocities obtained from the TMW test were within normal range for all 4 footwear styles, indicating gait stability regardless of the footwear styles. Previous study (67) reported a mean normal gait speed of 115.7±16.7 cm/sec for elder women 60 -69 years.

4. Other factors that may influence postural control ability of participants in the present study

As mentioned above, the beneficial effects of athletic shoes in enhancing postural control were expected to be more pronounced than what the results actually revealed. Although, all participants experienced wearing athletic shoes in their daily living, none rated the athletic shoes as the footwear they often wear. Participants reported that they only wear athletic shoes occasionally such as when they exercise. In contrast, participants often wear sandal and thong in their daily living. Thus, familiarization with the sandal and thong and non-familiarization with the athletic shoes may contribute to findings in the present study.

Participants in the present study were relatively healthy and none reported balance impairment. The mean age of the participants was 63.23 ± 3.22 years with the range between 60-69 years. This age range was studied because elderly women in

this age range often reported falls caused by extrinsic factors such as footwear (12). However, the significant differences were only observed on the difficult postural control tests such as TUG and standing on foam with eye closed.

Finally, some of the postural control tests used in the present study were not sensitive enough to detect differences in small magnitudes and some tests also reached ceiling effects (e.g. mCTSIB). More sophisticated laboratory tests may reveal the effects of footwear styles on postural control better than these tests. However, if the effects are too trivial to be revealed by clinical tests, then they may not have any clinical significance, and should not be of concern. Some issues, however, deserve further investigation. For example, results on TMW may be different if the walking was performed on irregular, uneven or wet surfaces which elders often encounter in their daily living.

5. Conclusion

Results from the survey study revealed that the top three footwear styles worn by Thai elderly women who live outside municipal limits were sandal (45.3%), followed by thong (28.8%), and high-heel shoes (12.4%). The results were inconsistent with previous study that reported athletic and canvas shoes (sneakers) as the most common footwear worn by Western elders. Factors including environment, culture, lifestyle, and socioeconomic status may influence the choice of footwear an individual chooses to wear. In the second part of the study, the impact of the three footwear styles obtained from the survey study and the athletic shoes on the postural control ability of elderly women were investigated. Overall, the participants demonstrated comparable postural control abilities for all four footwear styles in most of the postural control

tests, except for the modified CTSIB on foam surface with eye closed condition and the TUG test in which the athletic shoes showed better scores than the high-heel shoes and sandal. Using simple, clinical tests, athletic shoes appeared to provide better postural control than other footwear styles. Besides shoe features, factors such as participant's familiarization with the shoes, their physical condition and the sensitivity of the tests used in the study may also influence findings in the present study. Issues such as the impact of an interaction between footwear styles and surface characteristics (e.g. irregular, uneven, wet surfaces) on postural control ability are worth further investigation.

6. Limitations and suggestions

The presents study had certain limitations that needed to be considered. First, due to the relatively healthy participants, some clinical tests used in the study were not sensitive enough to detect postural instability induced by the footwear. More challenge postural control tests such as choice stepping reaction time test should be included. Second, gait characteristics were not investigated in the present study. It is well documented that changes in gait parameters are indicative of walking instability. Third, findings from this study cannot be generalized to elders over 69 years of age or frail elders. Footwear may have different impact in postural control of these populations. Therefore, further study should be conducted in the above populations. Finally, the effect of an interaction between footwear and walking surfaces such as irregular, uneven, or wet surfaces should be investigated.