CHAPTER V

DISCUSSION AND CONCLUSION

DISCUSSION

Injury analysis

The 48.4% injury rate reported in this study is in line with many reviews. According to a systematic review by Van Gent RN et al. (2007) reported overall incidence of lower extremity running injuries showed a large range (19.4% to 79.3%). Moreover, previous reviews reported ranges of 24% to 83% (Hoeberigs JH, 1992), 33% to 85% (Macera CA, 1992), and 24% to 77% (Van Mechelen W, 1992). Other documented injury rates of 25-65% (Macera C, 1989; Van Mechelen W, 1995). Besides, studies in the elderly have found that the incidence of jogging/running injuries was 31.5 – 57% (Matheson GO et al., 1989; Pollock ML et al., 1991). Furthermore, differences in injury definition used by different authors might further confounded appropriate comparison across studies (Jaunton JE et al., 2003). Also, investigators should try to use a universal definition of running injury, so that results could easily be compared (Van Gent RN et al., 2007).

Our finding that the knee (46.6%) was the most common site of injury is well supported (Marti B et al., 1988; Jacobs S and Berson B, 1986). The incidence of knee injury in this study is similar to previous results: Pinshaw et al (1984) reported that 44% of all injuries were at the knee (50% were runner's knee), and Clement et al (1981) found that 42% of running injuries affected the knee, with 60% of these were being due to PFPs (patellofemoral pain syndrome). Moreover, the knee is the principal power absorber, performing approximately 2 times the work of the ankle and the hip (David NMC. et al, 2001).

From the review by Van Gent RN et al. (2007) concluded that the most common site of lower extremity injuries was the knee (7.2% to 50.0%), followed by the lower leg (9.0% to 32.2%), the foot (5.7% to 39.3%), and the upper leg (3.4% to 38.1%). Less common sites of lower extremity injuries were the ankle (3.9% o 16.6%) and the hip/pelvis (3.3% to 11.5%). These results support Van Mechelen's conclusion that most of running injuries were located in the knee (Van Mechelen W, 1992).

Factors significantly associated with injury.

Gender, weight, arch type, leg length discrepancy, jogging duration per day, weekly mileage, stretching exercise, orthoses used, and history of injury were associate with running injury after univariate analysis (t-test and chi-square test). However, factors such as gender, arch type, stretching routine (holding time of each stretch) and previous injury remain significant after multivariate analysis (logistic regression model) in this study.

Male joggers had greater risk than female joggers (OR 3.801; 95% CI 1.279 to 11.292). The average age, weight, height of male were more significantly difference than female. Although, there was no significant difference between male and female in weekly mileage, but male ran more weekly mileage than female (28.25 vs. 24.69 km., respectively).

The only significant association for overall lower extremity running injuries showed a positive relation with female sex (Nicholl JP and Williams BT, 1982). There was also limited evidence that female runners were more prone to incur hip injuries, and limited evidence that male runners were at greater risk of getting hamstring or calf injuries (Satterthwaite P et al., 1999). However, it is important to note that the studies included in this study had few female participants therefore the results may not be generalisable.

We found that weight was statistical significance difference between injured and non-injured groups (mean weight: 67.61 vs. 64.79 kg., respectively). But this was not significantly associated with running injury after multivariate analysis.

Taunton et al (2002) found that women with a body weight of less than 60 kg. were at reduced risk of experiencing plantar fasciitis in this study. This is probably explained by the reduced stress/force applied to the foot musculature during running with a lower body weight. Conversely, there was limited evidence that greater weight was protective against foot injuries (Wen DY, 1998). However, Walter et al (1989) did not find a significant association between body weight and running injuries.

The Chi-square test showed that arch type of the left and right feet were statistical significance difference between injured and non-injured group ($p < 0.05$ and $p < 0.1$ of the left and right foot, respectively). Then, after multivariate analysis found the low arch foot had greater risk than high arch foot (OR 5.811; 95%CI 1.238 to 27.273).

Foot structure is commonly associated with lower extremity problems. Giladi et al. (1985) demonstrated that high-arched (HA) or normal subjects were more likely to develop stress fractures than low-arched (LA) people. Similarly, Cowan et al. (1993) reported that high-arched (HA) individuals had the greatest propensity toward injuries of the lower extremities when compared to runners with normal and low-arched (LA) structures. Additionally, HA individuals were reported to have an increased number of tibial and femoral stress fractures while LA subjects demonstrate a greater number of metatarsal injuries (Simkin A, et al., 1989). It was found that both HA and LA patients had greater incidences of knee injuries than patients with a normal arch structure (Dahle LK, et al., 1991). Conversely, it has been reported that a high arch was protective against all injuries in runners (Wen DY, et al., 1998). The same study found no relationship between low arch and injures.

Differences in the results of all of these studies may be related to the method of defining and categorizing arch structure. Some were based on visual observation (Dahle LK, et al., 1991), which has been shown to be unreliable (Cowan DN, et al., 1994). Others use footprint measures (Cavanagh PR and Rodgers MM, 1987), same as this study, which may not characterize the bony architecture well.

The value of leg length discrepancy ≥ 1 cm. tends to be significant injured than non-injured group (p <0.1). A leg length discrepancy of as little as ¼ inch (1 cm.) can cause sacroiliac or back pain or greater trochanteric bursitis on the side opposite the shorter leg (Brody DM, 1987).

However, Wen DY et al. (1998) concluded that minor variations in alignment of the lower extremities do not appear conclusively to be major risk factors for overuse injuries in runners. Similarly, Lun V et al. (2003) concluded that measurement of static lower limb biomechanical alignment were not found to be related to lower limb injury in recreational athletes.

The result from this study show that more in the injured group running more than 30 minutes per day than non-injured group, while more in the non-injured group running ≤ 30 minutes per day, this was significant different between injured and non-injured group. Similarly, previous study by Colbert LH et al (2000) found that compared with < 15 minutes per day, men running 15-30 minutes per day had a 36% higher risk of injury (OR 1.36, 95%CI 1.07 to 1.73), while men running more than 30 minutes per day were at a 52% higher risk (OR 1.52, 95%CI 1.14 to 2.04). There was no significant association between amount of daily running and injury among the women joggers.

We found more injured group jogging ≥ 32 km/week than non-injured group. However, the weekly jogging distance is not prove to be significantly associated with running injury in this study after multiple logistic regression model. This may be resulting from most joggers in this study jogged less than 32 km/week (mean: 31.43 km.) and most joggers were not prefer to change or increase of their distance per week.

Two high quality studies reported training for ≥ 64 km/week (Macera et al, 1989) and > 64 km/week (Walter et al, 1989) as a significant risk factor for male runners incurring lower extremity running injuries, while in female runners this association was only reported in one high quality study (Walter et al, 1989). In the reviews of Van Mechelen (1992) and Brill and Macera (1995), running distance was considered to be one of the strongest contributors to injury.

Excessive weekly distance can only be dealt with reducing running itself. However, this does not seem to be an acceptable measure for joggers who are determined to run. At the level of the individual runner the question 'How much is too much?' can only be answered by trial and error (Van Mechelen, 1994).

With regard to stretching exercise, we found joggers who say they hold each stretch for < 15 seconds to jog a greater risk than joggers who say they hold each stretch for > 30 seconds (OR 2.734; 95% CI 1.166 to 6.409).

Most participants preferred to perform stretching 1 time per stretch and hold < 15 seconds per each stretch. According to ACSM' guideline (2007) suggested that for optimal flexibility, hold each stretch for 15-30 seconds and repeats stretches 2-4 times. However, connective tissue deformation and neuroinhibitory effects require 30-90 seconds to effect tissue change and a relaxation response (Per-Olof A and Rodahl K, 1977; Garfin SR et al., 1981; Anderson B, 2000). Stretching and strengthening exercise help prevent and ease many running injuries. Stretching exercise (static not ballistic) should be done slowly and gently before, after, and (if necessary) during a run to maintain flexibility in the back, thigh, lower leg, and plantar structures (Brody DM, 1987).

Van Mechelen (1992) was not able to detect any preventive effect in terms of a reduction of running injury incidence from a standardized programme of warm-up, stretching exercises and cool-down in a randomized trial, in which runners were matched for age, weekly distance and knowledge on the prevention of running injuries. Similarly, Yeung and Yeung (2001) concluded from the collated analysis of the five studies evaluating stretching regimens, it was not known whether protection against injuries was afforded.

Nigg et al. (1999) claim that an appropriate orthosis reduces muscle activity, increases muscle performance, and feels comfortable. Although, more in injured joggers significantly use orthotics than non-injured joggers, there was no statistical significance difference between injured and non-injured group when separate the orthotic devices or external supports (e.g. heel support, arch support, insole support, knee support, ankle support, and calf support).

Most running shoes were made with removable insoles. Orthotic devices help the pronated foot maintain a more neutral position; for the cavus foot, they help provide more shock absorption (Brody DM, 1987). Yeung and Yeung (2001) cited experimental studies indicating that shock-absorbing insoles do not prevent overuse soft tissue injuries in military recruits (Schwellnus MP, et al., 1990; Smith W, et al., 1985). In addition, a knee brace appears to be effective in the prevention of anterior knee pain (BenGel S, et al., 1997), but this was based on only one study.

The results from the logistic regression show that a history of previous injury had a higher odds ratio of experiencing an injury (OR 9.996; 95%CI 4.974 to 20.088). This result was confirmed by previous studies. Several studies had identified previous injury as risk factors for running injury (Macera CA et al., 1989; Walter SD et al., 1989; Marti B et al., 1988; Powell KE et al., 1986).

A history of previous injuries was reported to be a significant risk factor for injures in multiple high quality studies (Macera CA, et al., 1989; Walter SD, et al., 1989; Wen DY and Puffer JC, 1998; Macera CA., 1991). Thus there was strong evidence for an association between a history of previous injuries and lower extremity running injuries. However, joggers with this risk factor should pay extra attention to signs of injuries, avoid other determinants of injuries, and take time to recover fully from their injuries.

Other associated risk factors for injury.

Age, body mass index, Q-angle, jogging frequency, jogging experience, jogging surface, and shoes (age of shoes and type of shoes) were not significantly associated with risk in our study, while several of these factors have been shown to be predictive in other studies and may cause some individual injuries.

Form the systematic review by Van Gent (2007) reported the greater age (a clear cut off point for greater age could not be observed) was reported to be a significant risk factor for incurring running injuries in four high quality studies (Nicholl JP and Williams BT, 1982; Stterthwaite P et al, 1999; Walter SD et al., 2003; Wen DY et al., 1998). However, in two high quality studies greater age was reported to be a significant protective factor (Stterthwaite P et al, 1999; Nicholl JP, 1982). However, in this study we did not compare between middle-aged and elderly joggers in injury rates.

In this study, most runners had normal weight (BMI: 18.5 – 24.9). It should be noted though that overweight amongst runners is a rare finding. There was limited evidence that a body mass index of >26 kg/m^2 protected male runners from overall lower extremity running injuries (Taunton JE et al, 2003). However, Macera et al. (1989) and Walter et al. (1989) both found that BMI was not related to running injuries in their respective multivariate regression model.

An excessive Q angle was considered indicative of extensor mechanism malalignment and had been associated with anterior knee pain (Boucher JP et al, 1992; Caylor D et al., 1993; Chen S, 1997), patellar subluxation or dislocation (Carson WG et al., 1984; Moskwa CA and Nicholas JA, 1989; Papagelopoulos PJ and Sim FH,1997; Zimbler S et al., 1980), and lower limb overuse injuries (Lysholm J and Wiklander J, 1992; Messier SP et al.,1991; Neely FG, 1998).

For diagnosing patellar abnormalities, the Q-angle was measured; a Q-angle greater than 20° is considered abnormal (Brody DM, 1987). Most participants in this study were Q-angle of $\geq 10^\circ$ - $< 15^\circ$. However, there was limited evidence that static biomechanical lower limb alignment was not related to lower limb injuries.

However, the effect of static lower limb alignment may be injury specific (Lun V et al., 2004).

It has been speculated that running frequency (days running a week) was not affect risk of injury in this study. In examining a subgroup running the same weekly distance in 2, 3 or 4 weekly sessions, Marti et al. (1988) reported no significant differences in the incidence of running related injuries. Consequently, it has been suggested that running frequency does not play a part beyond the effect of increased weekly mileage (Van Mechelen, 1992).

There was conflicting evidence for an association between inexperience in running and overall lower extremity injuries (Macera CA, et al., 1989; Nicholl JP and Williams BT, 1982; Stterthwaite P et al, 1999; Wen DY et al., 1998; Nicholl JP, 1982). In this study, most of joggers had experience up to five years. Van Mechelen W (1995) reported that the virtue of experience allowing a runner to 'listen to the language of their body' and know how to avoid possibly compromising training habits.

Jacobs and Berson (1986) did not find correlation between running surface and running injury, but this finding was probably biased by the fact that the majority of the runner in their study were running on concrete and alphalt. Also, in this study most of joggers were jogging on alphalt.

Walter et al. (1989) found no significant relation between injuries and frequency of running on asphalt, concrete, grass or dirt. James et al (1978) found no association of running on hard surfaces with increased risk of injury after controlling for weekly distance.

The results from this study with respect to age of running shoe reviewed that wearing shoe less than 6 months old was associated with injury. On the other hand, running in shoes more than 6 months old was associated with fewer injuries. However, there were no significant difference between injured and non-injured group. Although it was commonly felt that new shoes were protective against injuries by virtue of their cushioning and support qualities, it has also been suggested that injured runners may try to solve their problem by frequently changing shoes. The previous study by Taunton et al (2003), reported that newer running shoes (less than six months old) would appear to act as both a protective and risk factor for the onset of running related injuries in their population (recreational runners). Although this was speculation, these results illustrated the need to understand more clearly the direct effect of running shoe age on a large population of novice runners. The results of this study were inconclusive. The possibly reasons may be the available running shoes sold in Thailand were not suitable for all Thai joggers.

In addition, there was no significantly associate between wear and tear pattern of shoes and running injuries. Also, Walter et al. (1989) found the shoe characteristics (presence of varus wedge, waffle sole, wear and tear pattern and personal shoe repair) were not related with injury risk.

However, for a valid diagnosis, an extensive medical history (including examination of the wear and tear pattern of the patient's running shoes), physical and radiographic examination, and a biomechanical evaluation should be conducted (Brody DM, 1987).

Conclusion

The incidence of injury over the four months observation period was 48.4%, compared with previous reports in the elderly had found that the incidence of jogging/running injuries of 31.5% - 57.0%, this was quite high incidence for middle-age to elderly joggers. We found the risk factors through multivariate logistic regression modeling that male joggers, low arch foot, hold each stretch < 15 seconds during stretching exercise, and having histories of previous injuries were associated with running injury.

Factors such as age, BMI, Q-angle, jogging frequency (day per week), jogging experience, jogging surface, and shoes (type, age of shoes) were not statistically significant in any model.