DYNAMIC VARIABLES AND INJURIES IN RUNNING

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INTRODUCTION

Millions of people are involved in running and jogging activities. The reported yearly incidence of injury ranges between 37 and 56 % (Cavanagh, 1980; Frederick and Hagy, 1986; Matheson et al., 1988; van Mechelen, 1992). Dynamic variables such as excessive impact forces, excessive pronation, excessive pronation velocity and excessive knee joint moments have been proposed as major reasons for the development of running injuries (Nigg et al, 1977; James et al., 1978; Cavanagh and Lafortune, 1980; Clement et al, 1981; Cook et al., 1990; van Mechelen, 1992, Stefanyshyn et al., 1999). However, there exists a lack of prospective studies, which have identified dynamic biomechanical risk factors related to running injuries. Therefore, the purpose of this investigation was to determine if dynamic running variables are causally related to injury onset in a group of recreational runners with the use of a prospective study.

PROCEDURES

Baseline biomechanical data were collected on 143 runners prior to the beginning of the summer running season. All subjects wore their own footwear, which they used during the running season. Kinematic data were collected using a 4-camera high-speed (240 Hz) 3-dimensional motion analysis system. Reflective markers (3 per segment) were placed on the rearfoot, lower leg and upper leg. Kinetic data were collected (1000 Hz) using a force platform. Three trials were collected per subject. The running speed (4.0 +/- 0.2 m/s) was monitored using two photo-cells at shoulder height.

During a 6 month running period, subjects documented any injuries that developed. An injury was defined as any stoppage or decrease in running mileage. The influence of impact forces and impact loading rates, shoe eversion, shoe eversion velocity and resultant knee joint moments (abduction and external rotation) on injury were analyzed. For each variable, subjects were divided into three groups: the bottom 25%, the middle 50% and the top 25%. Injury rates for the different groups were compared using a Chi-square test (α=0.05).

RESULTS

Of the original 143 runners who started the study 83 completed the study. 66 of the 83 runners (80%) sustained an injury during the six month training period. There were no significant differences between injury rates for the low, mid and high groups for any of the variables analyzed. This was true despite differences in group injury rates of up to 30% in some instances (Table 1). Thus, it is possible that a larger number of subjects may have resulted in significant differences. The resultant knee joint moments showed the largest differences in injury rates where subjects with high knee joint moments had 20-30% more injuries than subjects with lower knee joint moments. The impact forces and loading rates showed the smallest differences in injury rates where differences between the different groups ranged from 3-5%.

Group	Percent of Injured Subjects Grouped According to					
	Impact Force	Impact Force Rate	Change in Shoe Eversion	Shoe Eversion Velocity	Knee Abduction Moment	Knee Ext.Rotation Moment
Low 25%	81.0	76.2	90.5	90.5	76.2	81.0
Mid 50%	78.0	80.5	78.0	82.9	73.2	68.3
High 25%	81.0	81.0	71.4	61.9	95.2	100.0

Table 1: Injury rates of subjects (in percent) grouped according to different dynamic variables measured during running.

DISCUSSION

This study does not support the commonly held belief that high impact forces and high impact loading rates are associated with running injuries. The rate of injury was independent of impact force and impact force loading rate. Thus, normal impact forces during running are probably not a major factor in the development of running related injuries.

There was a surprising trend when subjects are grouped according to shoe eversion. The injury rate appeared to decrease as the amount of shoe eversion increased which is contrary to what is generally proposed. The results were similar for shoe eversion velocity where the injury rate appeared to decrease as the rate of shoe eversion increased Thus, it is speculated that large amounts of shoe eversion are not related to an increased potential for injury.

The two variables that appeared to be the strongest predictor of injury were high external rotation and abduction knee moments. All 21 subjects who had high external rotation moments and 20/21 subjects who had high abduction moments at the knee sustained an injury in the six month running period. There is a strong possibility that increased transverse and frontal plane knee joint moments are contributing factors leading to injuries in runners.

REFERENCES

Cavanagh, P.R. *The running shoe book.* Mountain View, CA. Anderson World, Inc. 1980.
Cavanagh, P.R. and Lafortune, M.A. *J. Biomechanics,* **13**, 397-406, 1980.
Clement, D.B., et al. *Phys. Sports Med,.* **9**, 47-58, 1981.
Cook SD, et al. *Sports Medicine,* **10**, 1-8, 1990.
Frederick E.C. and Hagy J.L. J. *Sport Biomech.,* **2**, 41-49, 1986.
James S.L. et al. *Am. J. Sport Med.,* **6**, 40-50, 1978.
Matheson, G.O. et al. *Am. J. Sports Med.*, **15**, 46-58, 1989.
Mechelen W. van: *Sports Medicine*, **14**, 320-335, 1992.
Nigg, B.M. et al. *Medita*, **9a**, 160-163, 1977.
Stefanyshyn, D.J.et al. *Proc. Fourth Symp. Footwear Biomech.*, 86-87, 1999.