Athletic footwear affects balance in men

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Stable equilibrium during locomotion is required for both superior performance of sports and prevention of injuries from falls. A recent report indicated that currently available athletic footwear impairs stability in older men. Since this discovery, if confirmed, seems important to both competitive athletes and the physically active general public, we performed an experiment using similar methods on a younger population. We tested the hypothesis that midsole thickness is negatively, and hardness positively related to dynamic equilibrium, in 17 healthy adult men (mean(s.d.) age 33(11.13) years) via a balance beam method. Subjects walked along a 9-m long beam at 0.5 m s⁻¹ once barefoot and six times wearing identical pairs of experimental shoes which differed only in midsole hardness and thickness which spanned the respective ranges currently available in footwear. Falls from the beam (balance failures) were quantified. Balance failures varied significantly in relation to midsole hardness and thickness, and there was a strong trend toward interaction of these variables ($P = 0.09$). Midsole hardness was positively related to stability, and midsole thickness was negatively related, which confirms the previous report. Hence, shoes with thick-soft soles, similar to modern athletic footwear and 'walking shoes', destabilize men, and shoes with thin-hard soles provide superior stability. The pair with the poorest stability (A 15 - thick; 12.34 balance failures per 100 m) produced 217% more balance failures than those associated with the best stability (A 50 - thin; 3.89 balance failures per 100 m). Since most types of athletic footwear and many other shoes incorporate midsoles with hardness and thickness associated with poor stability, we conclude that both athletic performance and public safety could be enhanced through stability optimized footwear.

Keywords: Equilibrium, stability, balance, footwear, athletic footwear, shoes

Maintenance of stable equilibrium during locomotion (walking and running) applies to physical activity from two perspectives - athletic performance and injury. Athletic performance must be influenced

substantially by an athlete's stability, however, aside from obvious poor athletic performance shown by those with significant equilibrium impairment, such as vestibular disorders¹, and induced instability via calorics², it has not been quantified.

With respect to health, falls and their consequences are the most significant hazard associated with poor stability. Although falls in the older age group have life threatening consequences³⁻⁷, falls during locomotion in younger individuals account for considerable morbidity.

Falls are usually elicited by correctable extrinsic factors that produce disequilibrium, acting upon the individual's inherent stability, which declines with age in adults^{8,9}. Extrinsic factors include environmental causes of instability, such as slippery surfaces, pavement irregularities, loose rugs, poor lighting, footwear, and obstacles in passageways, to name a few. Most progress in preventing falls will come from identifying and mitigating environmental causes of instability³.

Footwear that incorporates expanded polymer foam of a certain range of thickness and hardness, which includes most commercially available athletic footwear, and presently popular 'walking shoes', has recently been reported substantially to impair equilibrium in older men. For example, these authors have shown that differences in fall frequency from a balance beam varied by an amazing 128%, when comparing footwear associated with the best stability with that of the poorest⁸. Since stability differences of this magnitude must have major health and athletic performance effects, products providing poor stability are currently being marketed to the general public specifically for use in performing physical activity (walking shoes and athletic footwear), and no safety standards are in force that can provide the public with relative stability with the use of these products. Further examination of the relation between footwear soles and stability seems justified.

The previous report examined footwear midsole hardness and thickness exclusively in an older male cohort⁸. It seems unwise to assume that their results apply to the general population without testing a younger group. Accordingly, the experiment that follows tests the hypothesis that stability in younger men is influenced by footwear midsole hardness and thickness.

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Methods

We adapted the balance beam testing method for use in this experiment^{10–14}. The narrow width of the beam places a fixed constraint on the strategy of moving the ipsilateral (the side towards which the centre of mass is displaced) leg laterally to maintain stable equilibrium. The requirement of forward locomotion on the beam at a constant velocity, places a constraint on other behavioural strategies humans use to retain and regain stable equilibrium during locomotion (e.g. prolongation of the double support phase; reduced forward velocity; reduced stride length). We placed the beam on the floor, and positioned a technician close to the subject, so that falls to the floor are prevented when subjects fail to balance on the beam (balance failures).

Apparatus

An extruded aluminium beam (cross-section outer diameter width 7.8 cm, height 3.9 cm; length 9 m) rested on 4-mm thick pads of carbon rubber (in order to reduce risk of beam movement across the floor), which contacted the floor. Beam width was selected so as to be wider than the soles of the experimental shoes. All subjects wore glasses which were modified by adding translucent adhesive tape to the lower two-thirds of both lenses, so as to prevent subjects from seeing their feet clearly and approximately 2 m of the beam in front of them. This method of visual information deprivation was based on a pilot study which showed that this technique produced adequate variation in balance failure frequency with subjects of the age used in this experiment, when combined with the width of beam used, and the relatively slow forward velocity. We feel that this method of visual information attenuation is valid insofar as during normal locomotion humans do not look at their feet or immediately in front of them when they normally walk or run. The relatively long beam length was chosen in preference to more typical shorter beams in order to reduce time lost by turning and remounting the beam. The floor adjacent to the beam was marked at 1-m intervals to aid the technician in estimating distance travelled by subjects to points of balance failures.

Subjects

A total of 17 subjects participated in the study who were of mean(s.d.) age 32.6(11.13) years (range 19–50 years) and mean(s.d.) height 176.4(4.95) cm (range 166.4–185 cm); mean(s.d.) weight 72.2(10.59) kg (range 56.8–102.3 kg). Fifty years was chosen as the mandatory upper age limit because a previous report and a pilot study we performed indicated that stability in men decreases thereafter. The compulsory lower limit of 18 years was selected to avoid ontological changes in stability. This experiment was limited to men in order to circumvent selection of subjects by foot size, because available shoe sizes could properly fit most men, but would fit a small percentage of women. Additional subject selection criteria were absence of disabilities influencing ability to walk, and no history of frequent falls.

Testing location

The room was well lit and devoid of furnishings barring experimental apparatus. The room was isolated so as to subdue auditory and visual distractions that might disturb subjects' concentration.

Hardness testing

A scale durometer (Shore) hardness testing was performed according to methods set forth by the American Society for Testing of Materials (Standard D 2240 – Standard Test Method for Rubber Property – Durometer Hardness)¹⁵. A larger value of A scale hardness connotes greater hardness.

Testing conditions

There were seven testing conditions – barefoot and six different pairs of experimental footwear. The footwear was similar to current running shoes – uppers fabricated from suede leather and nylon fabric; cement lasted; heel flare of 20°; outersole 5-mm thick carbon rubber (*Figure 1*). For each size, there were six different pairs of experimental shoes, which differed in midsole hardness and thickness, the experimental variables. The midsoles were composed of a uniform expanded polymer foam of hardness A 15, A 33 or A 50. These hardness choices were based on a pilot study which sampled current footwear. A 15 approximated the softest midsole, whereas A 50 corresponded to the hardest, and A 33 represents the mean. The most commonly used midsole hardness in current footwear that uses these materials was A 25. For each midsole hardness, there were two midsole thicknesses. The thinner midsole

Figure 1. Dimensions of sole materials of thick and thin shoe used in this experiment. Outer sole (lowest layer) was 0.5-cm carbon rubber. Midsole (middle layer between outersole and upper) was composed of expanded polymer foam of hardness A 15, A 33 or A 50. Hardness measured by Shore durometer using the A scale. The upper, which encloses the foot, was identical in all shoes used.

was 13-mm thick at the heel, and 6.5-mm thick at the site subtending the metatarsal-phalangeal joint. The thicker shoe's midsole was 27 mm at the heel and 16 mm under the metatarsal-phalangeal joint. These thicknesses correspond to the respective thinnest and thickest midsoles measured in a survey of currently available footwear of this construction. The shoes with thin midsoles and A 50 hardness resemble conventional leather or hard rubber walking shoes with respect to sole hardness and thickness.

Testing procedure

Subjects were told that the purpose of the experiment was to relate footwear features to balance. Their consent was obtained according to guidelines set forth in the Declaration of Helsinki of the World Medical Association. Subjects practised beam walking a minimum of ten, and maximum of 20 passes, by their choice. In order to pace subjects at a predetermined velocity, and to prevent falls to the ground, a technician walked backwards with the beam between his feet, at a constant velocity, 1 m in front of the subject. The rate of walking was fixed at 0.5 m s^{-1} , which was shown in a pilot study to be a relaxed walking pace with subjects of this age group. Subjects were instructed not to reduce the forward velocity even if it would help prevent balance failures. Upon falling off the beam, subjects were required to walk to the end of the beam before remounting rather than recommencing at the fall site (Figure 2).

There were ten passes down the beam for each testing condition. The distance from the beginning of the pass to the site of balance failure was estimated to the nearest metre and recorded. The order of presentation of the different shoes and walking barefoot followed a unique random series for each

Figure 2. Subjects walk forward and technician backward straddling the beam. Subject is told to maintain a fixed distance between himself and the technician. The technician paces the subject at a velocity of 0.5 m s^{-1} . The technician is sufficiently close to the subject so as to prevent subjects from falling to the floor after they fall from the beam.

subject. After completion of all test conditions, subjects were asked to identify the most comfortable shoe, as well as any uncomfortable ones.

Data analysis

Strength of relations among the seven test conditions and balance failure frequency were evaluated by two-factor analysis of variance for repeated measures. The two factors were midsole thickness (thin, thick) and midsole hardness (A 15; A 33; A 50). When significant *F* ratios were obtained, the relationships between specific pairings of conditions were assessed by *post hoc* paired *t* tests. Pearson product moment correlation coefficients were used to assess the relationship among variables of age, height and weight and balance failure frequency. An alpha level of 0.05 was used as the criterion for all tests of statistical significance.

Results

Balance failure frequency as a function of subject's age.

There was no significant relationship between balance failure frequency and subject's age ($r = 0.04$; $P = 0.33$).

Balance failure frequency as a function of subject's height.

There was a small but significant negative relationship between balance failure frequency and subject's height ($r = -0.21$; $P = 0.01$). The linear regression obtained is given by the following equation:

$$y = -0.35x + 69.3$$

where x = subject height in cm

y = balance failures per 100 m of beam walking

Balance failure frequency as a function of subject's weight.

There was no significant relationship between balance failure frequency and subject's weight ($r = -0.07$; $P = 0.23$).

Balance failure frequency as a function of test condition (Figure 3 and Table 1).

Analysis of variance for repeated measures indicated a statistically significant main effect for midsole thickness ($F(1,16) = 11.04$; $P = 0.004$), and midsole hardness ($F(2,32) = 11.12$; $P = 0.0002$). The interaction effect between midsole thickness and midsole hardness was not statistically significant, although there was a trend towards interaction ($F(2,32) = 2.48$; $P = 0.09$).

Post hoc t test revealed a statistically significant effect for midsole thickness (thin mean = 5.79 balance failures per 100 m; thick mean = 8.94 balance failures per 100 m; $t = 3.62$; $P = 0.0003$). In addition, significant differences between hardness A 15 and 33 ($t = 2.83$; $P = 0.003$), A 33 versus A 50 ($t = 4.38$, $P = 0.0001$) were obtained using *post hoc t* tests, and a strong trend toward differences between A 33 and A 50 ($t = 1.55$, $P = 0.06$).

Figure 3. Plot of balance failures (falls from the beam) as a function of midsole hardness for two sole thicknesses and barefoot conditions. Values are mean(s.e.). ●, thin midsoles; ▲, thick midsoles; ■, barefoot

Table 1. Balance failure frequency as a function of test conditions

Hardness	Thickness	Mean(s.e.)
15	thin	7.03(1.70)
33	thin	6.46(1.68)
50	thin	3.89(1.03)*
15	thick	12.34(2.19)†
33	thick	7.43(1.91)
50	thick	7.04(2.18)
Barefoot		10.79(2.19)‡

*Significantly lower balance failure frequency than any other test condition; †significantly higher balance failure frequency than any other test condition; ‡significantly higher balance failure frequency than five of six experimental shoe conditions

Balance failures with experimental footwear in relation to balance failures when barefoot.

There were significantly more balance failures when barefoot as compared with overall balance failures frequency with experimental footwear (mean barefoot = 10.78; mean footwear = 7.01; ($t = 2.79$, $P = 0.006$)).

Balance failure frequency as a function of order of presentation of conditions.

Balance failure frequency was significantly higher with the first testing condition encountered during the session compared with any that followed ($F(14,98) = 4.42$, $P = 0.0001$). There was no other significant difference in balance failure frequency in relation to presenting order.

Superior comfort as a function of experimental footwear midsole hardness and thickness.

Fifteen subjects judged shoes with midsoles A 15 – thick, and two subjects chose shoes with midsoles A 33 – thick, to be most comfortable. None chose shoes with other midsoles.

Discussion

Postural stability has been assessed either by individual tests or via test profiles. The profile method is exemplified by Fregley, whose 'Test Battery' was originally developed to infer relative stability of individuals with vestibular disorders¹. Profile approaches have limitations. The selection of tests used in profiles follows no logical plan, other than usage of methods in previously published reports, and adequacy in identifying certain individuals with obvious balance disorders. Tests included in profiles vary in validity, repeatability and sensitivity. The 'score', which is the unweighted average of the various tests, may poorly reflect actual stability of humans under a specific condition. Since we were interested exclusively in the situation when healthy humans normally fall, use of the profile method concerned us greatly – we chose to use an individual measure of stability, which required selection of a single method that was the most valid, sensitive and repeatable of all measures that have been used to test humans. Following selection of test type, further work was performed refining it (dealt with in a previous report)⁸. Method selection criteria deserve mention. We believe the method chosen, a modified balance beam method, to be the most valid in understanding stability in relation to human falls for a number of reasons. Unlike many methods, the task-specific constraints that the balance beam places on an individual attempting to retain or regain stable equilibrium resembles conditions associated with human falls in the natural condition, because falls almost always occur under environmental stress (usually impaired foot-ground contact, and during locomotion)¹⁶. Furthermore, the scientific literature has shown that the balance beam method is the most consistent in selecting those groups with neurological balance disorders, conditions known to cause falls^{1,2,12}.

This can be contrasted with measures of sway, a stability measure currently in fashion^{17,18}. Sway increases not only in individuals with poor stability, but also in those possessing superior stability when relaxed and unstressed¹⁷. Therefore it fails to distinguish the most stable from the least stable individuals. Further, sway is measured when standing rather than during locomotion when most falls occur.

Other popular methods infer stability of individuals via responses to provoked instability, by such means as tilting platforms or physically moving subjects¹⁸. These methods seem to lack validity for our purposes because they fail to examine subjects during locomotion, and the methods used to provoke falls poorly resemble initiation of most natural falls.

Perhaps our specific method's greatest attraction has been its repeatability. Our method produces results with the lowest standard error of any stability measure reported in the literature to date. For example, through pooling data from the present report and a previous one which used this method, we found that the standard error of the mean of balance failures was well under 4% ⁶⁸ (1.76 balance failures per 100 m). In addition, the method is exceptional in terms of reliability. As an example, 13 older subjects were retested on the balance beam 2 years after their first testing session in a different laboratory, by a different technician. The reliability coefficient was found to be a remarkable 0.91.

The results of the present experiment essentially confirm the results of the earlier report⁸. There were significant differences in stability in relation to midsole thickness and hardness in the pattern consistent with our hypotheses. Exchanging shoes with thin midsoles for thick-soled ones, increased balance failure frequency by 54.3% (thin mean = 5.80 balance failures per 100 m; thick mean = 8.94 balance failures per 100 m). Furthermore, changing from the hardest to softest midsoles increased balance failure frequency by 77.1% (mean A 15 = 9.69 balance failures per 100 m; mean A 50 = 5.47 balance failures per 100 m). Substituting shoes with the thickest and softest midsoles (poorest stability) for those incorporating the thinnest and hardest midsole (best stability), increased balance failure frequency by a remarkable 217%. There was a strong trend toward interaction between these two variables ($P = 0.09$). Clearly there is a positive relation between midsole hardness and stability, and a negative relation between midsole thickness and stability.

The data from the present experiment suggest performance could be improved if footwear used were optimized for stability. For example, diving and gymnastics, sports which stress balance considerably, are usually performed with bare feet. Our data showed 10.79 balance failures per 100 m when barefoot, whereas there were 3.89 balance failures per 100 m with the best shoe. If such a shoe were used by individuals performing these activities, the 64% decrease in balance failures would probably be reflected in improved performance due to improved stability. It should be noted the present experiment's best shoe was not an optimal shoe because the purpose of the present experiment was to span the range of sole thickness and hardness in available footwear rather than optimize these factors. Through optimization, it should be possible to produce a shoe capable of reducing balance failure frequency by far more than 64%.

Furthermore, sports such as football, basketball and racquet sports stress balance greatly. Since hardness and thickness of midsole material used in the soles of virtually all available footwear is suboptimal according to data from the present experiment and the previous report, improved stability, hence performance, could be anticipated in these sports with stability optimized shoes. We are presently testing stability in athletes using currently available commercial sports shoes with the goal of achieving a more stable shoe.

A comparison of the results of the present report, which used a young population, with those of a previous report employing an older cohort, is possible only to a limited extent⁸, since experimental procedures in both studies differed slightly. Notwithstanding this, the results indicate that the older subjects may be less affected by thick soles than younger individuals. For example, switching from thin to thick soles increased balance failures by 54.3% in the young (5.80 balance failures per 100 m to 8.94 balance failures per 100 m), but raised balance failures by 21.3% in the elderly (7.60 balance failures per 100 m to 9.23 balance failures per 100 m). By contrast, when considering sole hardness, changing from A 50 to A 15 in hardness increased balance failure frequency by 77.2% with the young (A 50 = 5.46 balance failures per 100 m; A 15 = 9.68 balance failures per 100 m), but by 93.2% in the older population (A 50 = 6.15 balance failures per 100 m to 11.88 balance failures per 100 m). Therefore changes in hardness affected stability more in the elderly than the young.

With 88.2% of the subjects selecting the shoe with A 15 – thick midsoles as most comfortable, there is support for the notion that midsole thickness is positively related to comfort and hardness is negatively related to comfort. However, none of the experimental shoes was judged uncomfortable. Since the shoe that imparted the greatest comfort also was responsible for the greatest instability, it seems sensible to caution individuals against optimizing foot comfort through choosing shoes with thick and soft midsoles. Relatively comfortable shoes with thin-hard midsoles should be preferred.

The present experiment does not identify the material property of expanded polymer foam, the main constituent of athletic footwear soles, that destabilizes. It is known that ankle motion in the medial-lateral plane is negatively related to midsole material hardness (soft soles cause increased ankle movement), caused by sole compressible material being eccentrically loaded (load applied near perimeter) during human locomotion (the lateral aspect of the heel is usually the point of first contact). We believe that these rapid ankle movements produce a confusing peripheral signal resulting in poor sense of actual ankle position (impaired proprioception). Ankle position sense is thought to be important in maintaining stable equilibrium in humans.

Another material property of midsoles that may contribute to instability is sensory insulation caused by expanded polymer foam. This sole material does not allow the plantar surface to deform from high amplitude localized vertical and horizontal loads. We have hypothesized that subjects underestimate the load they are experiencing and tend to overload during locomotion^{8,19}. Similarly, sensory insulation caused by thick-soft midsoles may make individuals unable to judge plantar pressure distribution. Plantar skin sense is known to contribute to stable equilibrium in humans. As far as preventing injuries to the general public, since most athletic footwear and many types of shoes marketed for casual use have yielding layers underfoot composed of material less than A 33 hardness – hardness that this experiment has shown is associated with suboptimal stability –

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there can be little doubt user stability could be improved, and falls prevented, if safety standards restricted footwear midsole thickness and required the use of harder materials.

To summarize, footwear with thick-soft soles, in the range of hardness and thickness seen in most current athletic footwear, and other footwear such as 'walking shoes', destabilize men. Since impaired stability worsens athletic performance, optimized footwear would have an anticipated benefit to competitive athletes. In terms of health, these data suggest a need for safety standards for footwear to protect users from falls and their consequences.

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References

- 1 Fregly AR. Vestibular ataxia and its measurement in man. In: HH Kornhuber, ed. *Handbook of Sensory Physiology: Vestibular System*, New York, USA: Academic Press, 1974: 321-60.
- 2 Fregly AR, Graybiel A. Labyrinthine defects as shown by ataxia and caloric tests. *Acta Otolaryng* 1966; **69**: 216-22.
- 3 Tideiksaar R. In: BE Gray, ed. *Slips, Stumbles and Falls: Pedestrian Footwear and Surfaces*. Philadelphia, Pennsylvania, USA: American Society for Testing and Materials, 1990: 17-27.
- 4 Wolf-Klein GP, Silverstone FA, Basavaraju N. Prevention of falls in the elderly population. *Arch Phys Med Rehab* 1988; **69**: 689-91.
- 5 Gabell A, Simons MA, Nayek USL. Falls in the elderly: predisposing causes. *Ergonomics* 1985; **28**: 965-75.
- 6 Tinetti ME, Speechely M, Ginter SF. Risk factors for falls among elderly persons living in the community. *N Engl J Med* 1988; **319**: 1701-7.
- 7 Wasson JH, Gall V, McDonald R. The prescription of assistive devices for the elderly: practical considerations. *J Gen Int Med* 1990; **5**: 46-54.
- 8 Robbins SE, Gouw GJ, McClaran J. Stability in older men in relation to footwear midsole hardness and thickness. *J Amer Geriatr Soc* 1992; **40**: 1089-94.
- 9 McMahon TA, Valiant G, Frederick EC. Groucho running. *J Appl Phys* 1987; **62**: 2326-7.
- 10 Assaiante C, Marchand AR, Amblard B. Discrete visual samples may control locomotor equilibrium and foot positioning in man. *J Mot Beh* 1989; **21**: 72-91.
- 11 Newsome BD, Brady JF, Gobile GJ. Equilibrium and walking changes observed at 5, 7½, 10 and 12 RPM in the revolving space simulator. *Aerospace Med* 1965; **36**: 322-6.
- 12 Auxter DM. Proprioception among intellectually typical and differentially diagnosed educatable mentally retarded boys. *Perc Mot Skills* 1965; **21**: 751-6.
- 13 Horvat MA. Effect of a home learning program on learning disabled children's balance. *Perc Mot Skills* 1982; **55**: 1158.
- 14 Heath SR. The military use of the rail-walking test as an index of locomotor coordination. *Psych Bull* 1943; **40**: 282-4.
- 15 American Society for Testing and Materials. Standard test method for rubber property-durometer hardness. *Annual Book of ASTM Standards*, Philadelphia, Pennsylvania, USA: ASTM, 1988, 09.01: 596-600.
- 16 Warren WH, Young DS, Lee DN. Visual control of step length during running over irregular terrain. *J Expt Psych* 1986; **12**: 259-66.
- 17 Wober C, Baumgartner C, Deecke L. Stabilizing and destabilizing effects of vision and foot position on body sway of healthy young subjects: a posturographic study. *Eur Neurol* 1989; **29**: 241-5.
- 18 Era P, Heikinen E. Postural sway during standing and unexpected disturbance of balance in random samples of men of different ages. *J Geront* 1985; **40**: 287-95.
- 19 Robbins SE, Gouw GJ. Athletic footwear: unsafe because of perceptual illusions. *Med Sci Sports Exerc* 1991; **23**: 217-22.

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