

Study of aeroball injuries

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Abstract

Objective—To present the risks of aeroball, a new sport played by either two or four players on a trampoline court surrounded by specially constructed fabric walls, and to propose ways to increase awareness and reduce the incidence of injury, in particular, ankle injury.

Method—A study was carried out to document the nature of aeroball related incidents, between 1991 and 1995, at Lancaster University Sports Centre. Lace-up ankle supports were introduced in April 1992, and their effect on the incidence of ankle injury was recorded.

Results—The lower limb received most injuries (90%), followed by the upper limb (6%), then the face (3%) and cervical spine (1%). The most common category of injuries was sprains (83%), followed by fractures (8%), contusions (5%), and dislocations (4%). The most common site of injury was the ankle (73%). It is during doubles play that injury is most likely to occur. Since the introduction of ankle supports, there has been a gradual decline in the incidence of ankle injury, 31 in 1991 to nine in 1995.

Conclusion—Aeroball has become a popular sport, but it is not without risks. Leaflets have been produced to promote the objectives, rules, and safety of the game. Trained full-time staff should be present to explain the nature of the game. The use of prophylactic ankle stabilisers in aeroball is strongly recommended.

(Br J Sports Med 1997;31:200-204)

Keywords: aeroball; trampoline; ankle supports

Aeroball is an exciting new sport that has recently become very popular in the United Kingdom. It combines the exhilaration of space, speed, and power. Lancaster University was the first in the country to introduce this game in October 1990. Since then, the game has been introduced at other universities, namely Liverpool, Keele, Manchester, and Essex.

Aeroball is played on a trampoline which is protected by special nets (fig 1). The court is divided into four quadrants (fig 2). The game can be played either as singles or doubles. In doubles, players are positioned opposite their team partners. The objective of the game is to gain points by shooting at an opponent's quadrant. A basket is achieved when the ball enters the top hole of the basket of the opponent's quadrant and drops below the centre line. A spike consists of a player aiming and throwing



Figure 1 Aeroball court.

the ball so that it bounces off the wall of an opponent's quadrant and on to the floor without the defending opponent touching it. After the initial serve, all the players are bouncing on the trampoline. Control of the ball consists of trapping the ball with the hands or between the feet. Once in control of the ball, any player has two bounces in which to make an offensive move, by either shooting at an opponent's basket or spiking an opponent's quadrant, or to pass the ball to his/her team partner. Any player can call time out if he/she feels it necessary to stop play.

The aeroball court is made of high quality materials to withstand the rigors of the forces involved. The player in each quadrant is surrounded by restraining nets, which prevent collisions between players. The outer perimeter fabric wall prevents the players from falling off the trampoline.

The trampoline plays a central role in the game of aeroball. It has been in use since 1936, and was first developed by George Nissen, a circus acrobat. Its popularity has soared and it has been used by gymnasts as well as for fitness exercises and even for training fighter pilots during the second world war.

A safety standard has been published to reduce the risk of injury,¹ and instructional methods have been proposed.² There have been several reports of serious cervical spine injuries as well as epidemiological studies researching the wider range of injuries caused

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Accepted for publication
14 May 1997

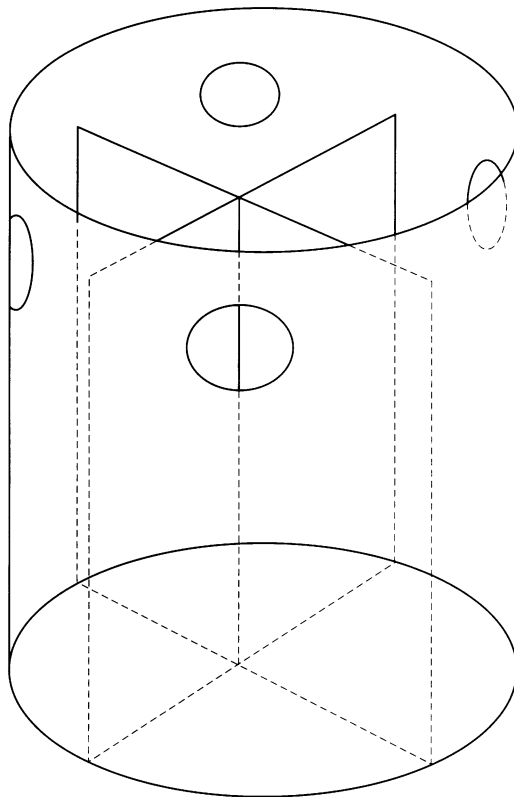


Figure 2 Diagrammatic representation of an aeroball court.

by trampolining sports.³⁻⁷ Chalmers and Langley⁸ reported that about 20% of injuries related to playground equipment and resulting in hospitalisation can be attributed to trampolines. The Standards Association of New Zealand have recently modified the American Society for Testing and Materials trampoline standard ASTM F381-84¹ which has been designated NZS 5855:1993.⁹

This is probably the first study in the literature about aeroball injuries. Although this game uses the trampoline, there are a few extra safety measures in the construction of the aeroball court. However, any activity involving motion or height creates the possibility of unintentional injury. This study focuses on the frequency of these injuries and methods of improving the safety standards of the game.

Methods

Aeroball was introduced at Lancaster University on the 5th October 1990. There are two courts located in the university's sports centre. Records are kept of those participants who are injured during play. It comprises a form, which is filled in at the time of the injury. Only in 1992 were the age and sex of the injured players noted; since then, these particulars have not been recorded.

Retrospective (for 1991) and prospective (1992-1995) studies were combined to document the number and types of injury incurred during games of aeroball. All injured players who attended the accident and emergency department of the Royal Lancaster Infirmary since 1992 were included in the study. All aeroball related incidents were coded and the information stored in the computer database.

Table 1 Total number of aeroball players/injuries. Figures in parentheses are annual incidence rates

Year	Players	Overall injuries	Ankle injuries
1991	17251	37 (21.4)	31 (18)
1992	14761	29 (19.6)	19 (12.9)
1993	9842	17 (17.3)	13 (13.2)
1994	8519	10 (11.7)	8 (9.4)
1995	8179	16 (19.6)	9 (11)

The players were either referred directly from the sports centre or they referred themselves. Some players with minor soft tissue injuries of the limbs did not attend the accident and emergency department. Information about their injuries were obtained from the sports centre accident forms. A small number who attended the university medical centre a day or two later for muscle aches were treated symptomatically and have not been included in the study.

There was a high incidence of referral of aeroball related incidents from the sports centre to the accident and emergency department in 1991. This prompted liaison (via R G M) with the sports authorities at the university. In April 1992, ankle supports were introduced, as ankle sprains were the commonest injuries. Follow up procedures looked at the incidence of ankle injury and the effect of ankle supports. It was not possible, however, to document how many players actually used the ankle supports. Therefore documentation was only available for players with injuries. They were specifically asked whether they used the ankle supports or not.

Injuries were coded according to the World Health Organisation's International Classification of Diseases (ICD-10) and Related Health Problems.¹⁰ Coding frames developed for the project were used to classify the type and body site of the injuries and the circumstances of the incidents.

Results

TOTAL NUMBER OF INCIDENTS

Table 1 shows the number of players and aeroball related incidents.

The annual incidence rates of injury decreased initially, from 21.4 per 10 000 players per year in 1991 to 11.7 per 10 000 players per year in 1994, but then rose again to 19.6 per 10 000 players per year in 1995 (fig 3).

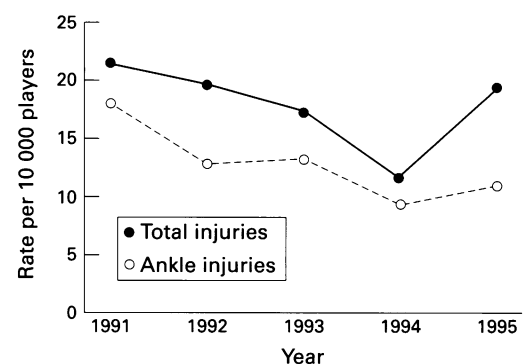


Figure 3 Annual incidence rates for total injuries and ankle injuries (1991-1995).

Table 2 Aeroball injuries (1991–1995). Values in parentheses in column 1 are total number of injuries

Year	Knee	Ankle	Foot	Leg	Shoulder	Hand	Face	Cervical spine
1991 (37)	3	31 (84%)		1	1	1		
1992 (29)	3	19 (66%)	4		1	1		1
1993 (17)	1	13 (76%)				2	1	
1994 (10)	1	8 (80%)	1					
1995 (16)	2	9 (56%)	2	1			2	

Table 3 Nature of injury

Category of injury	Number	Percentage
Sprain of ankle	72	66
Fractures of ankle	8	7
Sprain of knee (collaterals)	8	7
Sprain of foot	6	6
Superficial injury of face	3	3
Sprain of proximal interphalangeal joint	2	2
Contusion of leg	2	2
Dislocation of proximal interphalangeal joint	1	
Shoulder dislocation	1	
Talonavicular dislocation and rupture of deltoid ligament	1	
Fracture of proximal phalanx of fingers	1	7
Contusion of shoulder	1	
Knee dislocation	1	
Sprain of knee (ACL rupture)	1	
Sprain of cervical spine	1	
Total	109	

ACL, anterior cruciate ligament.

AGE/SEX OF INJURED PARTICIPANTS IN 1992

There were 13 men and 16 women injured (average age 22). The youngest player was a girl of 12 and the oldest was a man of 33.

NATURE OF INJURY

Table 2 presents the distribution of injuries to different parts of the body, and table 3 the frequency distribution of incidents by the nature of the injury sustained. The body site and the type of injury is categorised using the ICD-10 guidelines. The most common site was the ankle (73%), followed by the knee (9%), and the foot (6%). The lower limb accounts for the maximum number of injuries (90%), followed by the upper limb (6%), then the face (3%) and cervical spine (1%).

The most common category of injury was sprains (83%) followed by fractures (8%), contusions (5%), and dislocations (4%).

According to the ICD-10 classification of the external causes of morbidity and mortality, all incidents were accidental falls (W19). There were a few reports of overexertion (X50), but these were not included in the study. All incidents occurred at the sports centre.

SINGLES OR DOUBLES PLAY

Between 1992 and 1995 doubles play accounted for 64 incidents (89%), as compared with eight (11%) during singles play (table 4).

Table 4 Type of play

Year	No of players injured	
	Singles	Doubles
1992	2	27
1993	4	13
1994	—	10
1995	2	14
Total	8	64



Figure 4 Ankle support recommended for aeroball.

USE OR NON-USE OF ANKLE SUPPORTS

Of the 29 injured players in 1992, 15 were recorded to be wearing trainers. One was wearing boots, one socks only, and six were bare-footed. In six cases we could not determine whether or not any footwear was used. None were wearing ankle supports as recommended by the member of staff at the main reception. In all the following years, it was noted that the injured persons did not use ankle supports during play.

SEASONAL VARIATION

This was recorded only for the year 1992. It was hypothesised that a greater proportion of injuries would occur at the beginning of the term in October or November, as at this time there are new admissions to the university. This was not found to be the case, and the injuries seemed to be almost evenly spread out during the year. There was a slight increase in the latter half of the year in April and May.

ANKLE INJURIES

Since the introduction of ankle supports in April 1992 the absolute number of ankle injuries have decreased from 31 in 1991 to nine in 1995 (table 1). The annual incidence of ankle injuries has dropped from 18 in 1991 to 11 in 1995 (table 1 and fig 3). The proportion of ankle injuries in relation to overall injuries dropped from 84% in 1991 to 56% in 1995 (table 2).

The trend in incidence rate of total and ankle injuries was estimated using logistic regression. This showed a yearly decline of 13.5% (95% confidence interval -26.7% to +2%) ($P = 0.08$) for ankle injuries, and a yearly decline of 7.2% (95% confidence interval -19.1% to +6.5%) ($P = 0.28$) for total injuries.

Discussion

Every child has gone through a phase of bouncing on a bed. The Eskimos, going back hundreds of years, were very adept at tumbling on walrus skin stretched between stakes or held by friends. The trampoline has great appeal to gymnasts and fitness experts as well as to those who use it for recreational sports. Most reports focus on injuries to the cervical spine, but injuries to the upper and lower extremities are more common than either head or spinal injuries.³⁻⁵ The most common cause of injury involves the victim falling off the trampoline and striking the ground surface or an external object (80%), followed by the victim falling on to the bed of the trampoline (8%), and the victim striking the frame of the trampoline (2%).⁵ Manoeuvres such as somersaults have a high potential for spinal injuries. Aeroball uses the trampoline but with a great many safety measures. Each player is in a confined space protected by nets on the inside, which prevent collisions with other players. The players are also protected by an outer fabric wall which prevents them from falling out or striking the frame of the trampoline. In aeroball, dangerous manoeuvres such as somersaults are not performed.

Aeroball also involves the use of the upper limbs as in volleyball. Hand injuries occur infrequently in volleyball.¹¹ Sprains and strains are observed most frequently followed by fractures and contusions. In this study there were four reported cases, one being a fracture of the proximal phalanx and the other a dislocation of the proximal interphalangeal joint of the finger. Two further soft tissue injuries of the fingers were recorded in 1993 (table 3). Any throwing or overhead motion is a stressful activity and this places a great physical demand on the shoulder leading to shoulder injury.¹² Glenoid labral tears may result as a consequence of this dynamic activity with or without glenohumeral instability. In this study only two shoulder injuries were reported, one a dislocation and one a soft tissue injury.

Ankle injuries are common at many levels of athletic participation. Ankle sprains make up 55% of all basketball accidents.¹³ A relatively recent approach to injury intervention is the use of prophylactic ankle stabilisers.¹⁴ Although ankle bracing may prevent injury, many players believe that braces restrict athletic performance.¹⁵ This belief discourages the use of braces and obviates the injury protection that bracing provides. It has been well documented that ankle supports have a tremendous effect during strenuous physical activity.¹⁶ Studies have been carried out in football and basketball players, and show that ankle braces significantly restrict inversion immediately after the application of the brace and after 20 and 40 minutes of exercise.¹⁶ It has also been concluded that prophylactic ankle bracing does not inhibit athletic performance.¹⁵ However, Burks *et al*¹⁷ showed that bracing can limit the performance of the athlete. Their study compared three different prophylactic ankle braces, including taping, with no protection at all. Mayhew¹⁸ also found that taping athletes'

ankles decreased performance in the vertical jump and standing broad jump compared with their performance without taping. Juvenal¹⁹ reported similar findings for vertical jump ability. Therefore use of ankle supports may be useful for injury protection by restricting movements of the ankle, but the risk of decreased performance may cause the athlete to discard them.

We considered these points when selecting an ankle brace for aeroball. The primary aim in a prophylactic ankle support is to prevent undesirable inversion and eversion. There should be minimum restriction to dorsiflexion and plantar flexion. This type of ankle brace is least likely to affect performance. Similar recommendations have been made by Burks *et al*¹⁷ and Greene and Wight.²⁰ Keeping these factors in mind, we selected a lace-up ankle brace for aeroball (fig 4). Moreover, Rovere *et al*²¹ found that lace-up braces provided superior injury protection as compared with taping. The laced ankle support used at Lancaster University Sports Centre for aeroball is made of three full layers of nylon/vinyl fabric and reaches well above the ankle, affording support to prevent, as well as control, inversion injury. It has spring steel stays which provide necessary stability, and an extended elastic heel and a sewn-in arch for better support and comfort. It also has a notched front for easy flexion and extension, and incorporates an exclusive elastic forefoot for easy application, less bulk, and minimal tongue migration.

Initially the effect of the use of ankle supports on the injury rate was disappointing. On further investigation it was apparent that not all of the part time employees of the sports centre were offering these supports. Since full time staff have been employed, the importance of wearing ankle supports is emphasised to players. The decrease in the number of ankle injuries illustrates the importance of preventive measures.

Each year ankle sprains account for a significant degree of disability and expense.²² In aeroball, lower limb injuries are commonest (91%). As ankle sprains comprise the bulk of the problems, we strongly recommend the use of prophylactic ankle stabilisers.

A further prospective study is needed to find out how many players actually wear ankle supports. We could then compare the injury rates for wearers and non-wearers.

It is during doubles play that injury is most likely to occur. It is understandable that during this type of play it is impossible for a player to anticipate the positioning of the other three players, as the trampoline is in a constant unpredictable state of motion. If a player misses his/her balance, he/she is likely to land awkwardly, causing damage to ankles, knees, or arms. Only one case of neck injury has been reported in five years.

When aeroball was introduced in October 1990, it proved to be extremely popular among the university students as well as the general public. Over the first two years, this game over-represented all other sports. As people have become more aware of the strenuous nature of

the game, the numbers have fallen (table 1). There is now increased awareness of the dangers of this sport. Leaflets have been printed to promote the objectives, effects, and safety of the game. A strict policy has been made beginning at the main reception centre. There are trained full time staff who spend a few minutes explaining how to play the game as well as promoting the benefits of the ankle supports.

Aeroball is a popular sport but it is not without risk. Therefore the following measures could in the long term reduce the incidence of injury: (a) strict use of ankle supports; (b) single play only allowed.

The authors would like to thank Mrs Tracy Lawrenson for preparing the manuscript and Ms Sally Hollis of the Medical Statistics Unit at Lancaster University. Thanks also go to members of the staff at the sports centre at Lancaster University for their valuable assistance, especially Miss Sarah Lofthouse.

- 1 American Society of Testing and Materials. *Standard consumer safety specification for components, assembly and use of a trampoline (ASTM F381-84)*. Philadelphia: American Society for Testing and Materials, 1984.
- 2 Hennessy JT. Safety awareness and trampoline skills. *Journal of Physical Education and Recreation* 1980;51:36-8.
- 3 Larson BJ, Davis JW. Trampoline related injuries. *J Bone Joint Surg Am* 1995;77:1174-8.
- 4 Silver JR, Silver DD, Godfrey JJ. Trampolining injury of the spine. *Injury* 1986;17:117-24.
- 5 Chalmers DJ, Hume PA, Wilson BD. Trampolines in New Zealand: a decade of injuries. *Br J Sports Med* 1994;28:234-8.
- 6 Hammer A, Schwartzbach AL, Paulev PE. Trampoline training injuries: one hundred and ninety five cases. *Br J Sports Med* 1981;15:151-8.
- 7 Woodward GA, Furnival R, Schunk JE. Trampolines revisited: a review of 114 pediatric recreational trampoline injuries. *Pediatrics*. 1993;89:849-54.
- 8 Chalmers DJ, Langley JD. Epidemiology of playground injuries resulting in hospitalisation. *Journal of Paediatrics and Child Health* 1990;26:329-34.
- 9 Standard Association of New Zealand, New Zealand Standard. *Consumer safety specification for components, assembly and use of a trampoline. (NZS 5855:1993)*. Wellington: Standards Association of New Zealand, 1993.
- 10 World Health Organisation. *International statistical classification of diseases and related health problems. Tenth Revision*. Geneva: World Health Organisation, 1992.
- 11 Bhairo NH, Nijster MW, Von Doleri KC. Hand injuries in volley ball. *Int J Sports Med* 1992;13:351-4.
- 12 Andrews JR, Kupferman SD, Dillman SJ. Labral tears in throwing and racquet sports. *Clin Sports Med* 1991;10:901-11.
- 13 Raschka C, Glaser H, de Marees H. Etiological accident types and recommendations for prevention in basketball. *Sportverletz Sportschaden* 1995;9:84-91.
- 14 Sittler MR, Horodyski M. Effectiveness of prophylactic ankle stabilisers for prevention of ankle injuries. *Sports Med* 1995;20:53-7.
- 15 Pienkowski D, McMarrow M, Shapiro R, Caborn DN, Stayton J. The effect of ankle stabilisers on athletic performance. A randomised prospective study. *Am J Sports Med* 1995;23:757-62.
- 16 Tweedy R, Carson T, Vicenzino B. Leuko and Nessa ankle braces: effectiveness before and after exercises. *Aust J Sci Med Sports* 1994;26:62-6.
- 17 Burks RT, Bean BG, Marcus R, Barker HB. Analysis of athletic performance with prophylactic ankle devices. *Am J Sports Med* 1991;19:104-6.
- 18 Mayhew JL. Effects of ankle taping on motor performance. *Athletics Training* 1972;7:10-11.
- 19 Juvenal JP. The effects of ankle taping on vertical jumping ability. *Athletics Training* 1972;7:146-9.
- 20 Greene TA, Wight CR. A comparative support evaluation of three ankle orthoses before, during and after exercise. *J Orthop Sports Phys Ther* 1990;11:453-66.
- 21 Rovere GD, Clark TJ, Yates CS, Burley K. Retrospective comparison of taping and ankle stabilisers in preventing ankle injuries. *Am J Sports Med* 1988;16:228-33.
- 22 Rifat SF, McKeag DB. Practical methods of preventing ankle injuries (review). *Am Fam Physician* 1996;53:2491-8, 2501-3.

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