A Novel Design of Ankle-Protective Basketball Shoes

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Abstract. With the development of society, the functions of shoes are becoming increasingly diverse, and there is also various professional differentiation. Due to the high performance requirements for shoes, special sports shoes have emerged with the progress of time. Basketball shoes are one type of sports shoe that can reduce impact during jumping, protect ankles, and enhance grip. In order to minimize potential injury risks in basketball, we propose a design that combines ankle protection with basketball shoes. Through a questionnaire survey, we found that basketball shoes have a stronger market presence among women and individuals with lower body weight; they also hold certain appeal for non-basketball players. I believe that continuous improvement and development will enable basketball shoes to better protect athletes while providing people with an excellent sports experience.

Keywords: basketball shoes; ankle joint design; shock absorption; ankle bandage

1 Introduction

Sports shoes are special shoes designed and manufactured according to the characteristics of people participating in sports. The sole of sports shoes is different from ordinary shoes, which can play a buffer role in the process of exercise. At present, the market of sports shoes is developing rapidly, and professional athletes also use professional sports shoes to improve their sports performance. At the same time, sports shoes themselves have become one of the cultural symbols of young groups[1]. Since the 20th century, with the development of science and technology and the times, people pay more and more attention to the healthy relationship between shoes and feet. People began to pay attention to the specific role of shoes, especially during the first world war, because the design of the boots was flawed and not suitable for the needs of trench warfare, especially the poor performance of permeability, resulting in many non-combat attrition[2]. After learning the above lessons, there have been various professional differentiation in shoes. Because of its high performance requirements for shoes, special sports shoes have emerged with the development of the times.

Compared with other types of sports, basketball is more likely to cause ankle injury. Previously, researchers observed 10,393 basketball players and found that basketball
poses a great threat to the ankle joint. Ankle tape of athletes with a history of ankle injury also has a tendency to reduce the risk of ankle injury [3-5]. Some experimental results also show that the height design of basketball-specific sneakers can reduce the risk and degree of ankle sprain by increasing resistance to a certain extent [6]. At the same time, some studies have also pointed out that good basketball shoe design can help reduce foot load, significantly reduce the occurrence of metatarsal stress fracture and foot overuse injury [7]. Therefore, a good basketball shoe design helps to reduce the risk of injury during exercise [8].

At present, there are many directions in the design of basketball shoes, including the design of soles and uppers. Studies have shown that better and softer sole cushioning helps to enhance impact in passive or accidental situations. At the same time, the design of high upper can effectively increase the stability of ankle joint during jumping [9]. At the same time, because basketball is not like football and other sports that require continuous running, its design is aimed at lateral stability, torsional flexibility, buffering and traction control to reduce the risk of injury[10]. In recent years, many basketball-specific techniques have been proposed. In the design of soles, manufacturers around the world have proposed sole technologies such as Suspension shock absorption sole technology, Nike air Zoom, and ANTA A-core shock technology, and have achieved good results in terms of shock absorption[11][12]. In terms of improving jumping ability and reducing injury, Adidas TM has proposed Harden Vol.3 and SM Pro designs, which have achieved good results in the study control. Through quantitative performance tests, it is found that it may help to reduce non-contact ankle and lower limb injuries [8][13]. Studies have shown that the high-top design helps to increase the support of the ankle joint and reduce the range of ankle valgus[14]. In addition, many researchers have pointed out that support operations such as adding support plates or bandages can help reduce the risk of injury during exercise[15-16].

In order to reduce the potential risk of injury during basketball, we propose a design that combines ankle protection and basketball shoes. It has significant advantages in foot support and ankle protection. And through the questionnaire survey to verify the effectiveness of the design.

2 Methods

2.1 The design of soles

In terms of soles, as shown in Figure 1, this basketball shoe will use non-marking unmarked rubber on the out sole to improve the grip of the sole. Supercritical foamed PEBA will be used in the middle bottom(figure 2), and the shock absorption performance and resilience of the material are very excellent. The sole filler will use a Zoom cushion to ensure that the sole has a good cushioning shock, so as to reduce the damage to bones and muscles caused by the impact of violent bounce. In order to improve the support of the sole to the arch, a carbon plate made of carbon fiber will be added to the sole to support the arch, thereby reducing the probability of sprains caused by standing instability.
Fig. 1. Sole design drawing: the center for the sole carbon board, the rest of the use of traceless rubber

Fig. 2. Shoe sole profile: The middle of the forefoot and hindfoot is filled with supercritical foamed PEBA, and the rest is filled with ZOOM air cushion.

2.2 The design of shoe uppers

According to relevant studies, there is no significant statistical difference between the design of high and low sides in reducing ankle injury [18]. Therefore, we use the ankle elastic bandage instead of the ordinary full-wrapped ankle shoe design to avoid the problem of the low side of the ordinary high side (figure 3). The traditional high-end design will affect the activity limit of the ankle joint [17]. Our design is the upper part of the separated ankle protection part, using several adjustable elastic straps to connect to the shoe opening and add a pasteable part on it, so that it can be pasted together to form a cross-shaped ankle protection form. It effectively avoids the problem that the traditional high-side design will affect the activity of the ankle joint.

Fig. 3. Separated ankle protection part of the shoe upper diagram: At the upper right is the ankle banded shoe upper
2.3 Shoe upper design

In terms of uppers, in order to make the shoes more breathable, a breathable net will be added to the uppers. At the same time, in order to meet the different needs of different foot types for shoe width, the design of magic sticker will be added to the upper of the shoe to better wrap the foot surface. In order to better protect the ankle, GEOFIT structural design will be used in the shoe to provide better support and package for the ankle (figure 4).

Two carbon fiber support plates will be added on the inner and outer sides of the shoe to prevent the user from rollover during fast running. At the same time, in order to prevent rollover, a part of the sole will be widened as a torsional support part (figure 5).

![Fig. 4](image1.png)

**Fig. 4.** The upper part of the diagram is the permeable network, and the left and right sides are anti-torsion support parts.

![Fig. 5](image2.png)

**Fig. 5.** In the middle of the diagram is the carbon fiber support plate, and the upper right is the ankle bandage.

2.4 questionnaire design

A total of 92 questionnaires were received, including 60 males and 32 females. The age ranged from 13 to 28 years old, and the weight ranged from 39 to 116 kg. Including basketball, running, badminton, table tennis, football and other
types of sports fans. We consider that the design of the basketball shoes can meet the needs of sports, can reduce the risk of sprain, compared with other sports shoes on the market has obvious advantages as one point, otherwise recorded as -1 points, not clear whether it can meet the needs of sports or whether it can reduce the risk of sprain recorded as 0 points. In order to verify the significance of the questionnaire results, we adopted the method of statistical test between the results and Chance level. A paired T-test with a two-tailed distribution was used for statistical test.

3 Results

According to the results of the questionnaire, most people believe that the design can meet the needs of daily sports, while helping to reduce the risk of injury, and is superior to the existing sneaker design on the market. The three average scores were 0.68, 0.59 and 0.26, respectively, which were significantly higher than the chance level \( (p = 2.0\text{E}-20, 3.35\text{E}-19, 4.6\text{E}-07 < 0.001) \). The results are shown in Figure 6.

![Fig. 6. Results of questionnaire collection: The distribution of the questionnaire and the Chance level were statistically tested \( (p = 2.0\text{E}-20, 3.35\text{E}-19, 4.6\text{E}-07 < 0.001) \).](image)

As shown in Figure 7, from the perspective of men and women. Most men think that the design can meet the daily sports needs and help reduce the risk of injury, but there is no obvious advantage for the existing sports shoes design on the market. The average scores of meeting exercise needs and reducing injury risk were 0.62 and 0.58, respectively, which were significantly higher than those of chance level \( (p = 6.77\text{E}-14, 8.14\text{E}-13 < 0.001) \). However, the male group did not think that the design was significantly better than the existing sneaker designs on the market, with an average score of 0.1 \( (p = 0.18) \). The female group believes that the design can meet the daily sports needs, while helping to reduce the risk of injury, and is superior to the existing sneaker design on the market. The average scores of the three items were 0.81, 0.59 and 0.56, respectively, which were significantly higher than the chance level \( (p = 2.04\text{E}-07, 1.56\text{E}-07, 0.0001 < 0.001) \).
Fig. 7. The questionnaire collected the results of men and women: The results of statistical test of male questionnaire distribution and Chance level were \( p = 6.77 \times 10^{-14}, 8.14 \times 10^{-13} < 0.001, 0.18 \). The results of statistical test of female questionnaire distribution and Chance level were \( p = 2.04 \times 10^{-07}, 1.56 \times 10^{-07}, 0.0001 < 0.001 \).

Fig. 8. Questionnaire results of people of different weight segments: The results of statistical test between the distribution of questionnaires with body weight higher than 60 kg and Chance level were \( p = 1.23 \times 10^{-10}, 5.73 \times 10^{-09} < 0.001, 0.8 \). The results of statistical test between the distribution of questionnaires with weight less than 60 kg and the Chance level were \( p = 5.52 \times 10^{-10}, 4.41 \times 10^{-10}, 1.13 \times 10^{-06} < 0.001 \).

From the perspective of different weight, the results can be seen in figure 8. Most people who weigh more than 60 kg believe that the design can meet the daily sports needs and help reduce the risk of injury, but there is no obvious advantage for the existing sneaker design on the market. The average scores of meeting exercise needs and reducing injury risk were 0.67 and 0.56, respectively, which were significantly higher than those of chance level \( p = 1.23 \times 10^{-10}, 5.73 \times 10^{-09} < 0.001 \). However, the male group did not think that the design was significantly better than the existing sneaker design on the market, with an average score of \(-0.02 \) \( p = 0.8 \). Groups weighing less...
than 60 kg believe that the design can meet the daily needs of the movement, while helping to reduce the risk of injury, and is superior to the existing sports shoes design on the market. The average scores of the three items were 0.72, 0.65 and 0.63, respectively, which were significantly higher than the chance level (p = 5.52E-010, 4.41E-010, 1.13E-06 < 0.001).

From the perspective of whether to play basketball. Most people who play basketball think that the design can meet the daily sports needs and help reduce the risk of injury, but it has no obvious advantage over the existing sneaker design on the market. The average scores of meeting exercise needs and reducing injury risk were 0.67 and 0.64, respectively, which were significantly higher than those of chance level (p = 7.24E-10, 3.16E-8 < 0.001). However, the male group did not think that the design was significantly better than the existing sneaker designs on the market, with an average score of 0.11 (p = 0.25). The group that does not play basketball believes that the design can meet the daily sports needs, while helping to reduce the risk of injury, and is superior to the existing sneaker design on the market. The average scores of the three items were 0.7, 0.55 and 0.36, respectively, which were significantly higher than the chance level (p = 6.96E-012, 3.31E-011, 3.72E-06 < 0.001). The results can be seen in Figure 9.

![Questionnaire Results (basketball player)](image1)
![Questionnaire Results (non-basketball player)](image2)

**Fig. 9.** The questionnaire results of the people who play basketball and the people who do not play basketball: The results of the statistical test of the questionnaire distribution and Chance level of the basketball population were (p = 7.24E-10, 3.16E-8 < 0.001, 0.25). The results of the statistical test of the questionnaire distribution and Chance level of the non-basketball crowd were (p = 6.96E-012, 3.31E-011, 3.72E-06 < 0.001).

### 4 Discussion

In terms of gender differences, because men and women pay different attention to sports shoes. Women pay more attention to safety performance [18]. In basketball, there are differences in the way men and women exert their strength, [19] resulting in different evaluations of the design of the sneakers in the male and female groups. Most of the men and women think that the sneakers can meet the needs of daily sports and
reduce the risk of injury, but the female group is more convinced that the sneakers have obvious advantages over other sneakers than the male group.

In terms of weight difference, due to the higher demand for basketball shoe design among high-weight people, people who weigh more than 60 kg do not think that the shoe has obvious advantages. However, according to the data, most of the people with lighter weight are more satisfied with the shoes. They believe that they can meet the needs of daily exercise and reduce the risk of injury. At the same time, they have some obvious advantages, such as strong grip, good air permeability and light weight.

Because basketball shoes do not require continuous running, the design requirements are not as demanding as other sports. Therefore, for people who do not play basketball, the shoes can meet their needs well. Most of the people who do not play basketball think that the shoes have obvious advantages over other sports shoes.

In the questionnaire survey, 31 people described the additional advantages of the product. Including they said that the design has the advantages of strong grip, good permeability, good ankle protection, good permeability and so on. We feel that this design has the possibility of further digging in the direction of appearance and lightness. In terms of appearance design, the pattern can be added to the magic sticker to make the entire upper distinctive. According to the results of the questionnaire, the basketball shoes have good market value.

References


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