

Protective Glove Designs to Reduce Skateboarding Injuries

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Abstract: *Background:* Skateboarding continues to gain promotion and popularity. However, the availability of protective clothing is limited, resulting in an increase in cases of injuries and hospital emergencies. Thus, protective gear is necessary, particularly in the wrist area, which is commonly neglected. *Purpose:* This research was conducted with beginner skateboarders as the subject. In order to reduce the risk of damage, protective gloves should be designed to shield the wrist from harm from falling. *Method:* Literature research method and market research method were used to study the fall injury situation of beginner skateboarders and the mechanism of fall. *Findings:* Beginner's wrists (67.66%) are the most vulnerable and neglected part being protected, because of the body's inertia and physiological reactions, skateboarders unintentionally use their hand's palm to hold onto the ground that can lead to a distal radius fracture. *Conclusion:* In view of the above, this paper aims to design a kind of protective gloves to prevent skateboarding injuries, combines skateboarding gloves with protective airbags in the form of intelligent braking system, creates several sets of appearance programs for questionnaire surveys, design to meet the current trends in fashion while ensuring safety and protection, and to provide some guidance on the future of skateboarding sportswear.

Keywords: Skateboarding gloves; Protective glove design; Skateboarding; Skateboarding injuries; Skateboarding wearing apparel

1. Introduction

1.1 Research Background

In 2020, China's skateboarding team was recognized in the Tokyo Olympic Games. A 16-year-old player Zeng Wenhui achieved sixth place, then in the year 2023 at the Hangzhou Asian Games, 15-year-old Chen Ye, won the championship in the men's bowl pool skateboarding competition. Skateboarding in China began in the 1980s, but due to the "show yourself" spirit that is contrary to the traditional Chinese family concept and the high cost of skateboarding equipment, the sport quickly became inactive. However, in 2001, skateboarding sports brands started to diversify, and skateboarding in China eventually started to reach a new peak and became a career. Skateboarding gained more attention when it entered the Olympics in 2006 (Wang, 2022). In the process, skateboarding has grown to be one of the most popular sports among youth. The state has issued pertinent policies, such as in 2016, the State Council Office initiated the "Guiding Opinions on Accelerating the Development of Fitness and Leisure Industry," which aims to promote the sustainable development of overall fitness as well as the development of fashion sports (Chen, 2022).

In recent years skateboarding has been a free-form development state in China. It serves as a form of personalized, exciting street culture sports, with a certain degree of risk-taking that attracts more young people to express themselves to the public. Skateboarders use skateboards to brush the streets, fly by, and enjoy the venue at shopping malls, streets, parks, squares, and university campuses. This not only effectively promotes the physical health of the youth but also contributes to commercial

and artistic value in society, all of which are beneficial to the development of China's skateboarding movement (Ding, 2020).

Skateboarding's growing popularity has led to an annual rise in the number of accidental injuries in hospitals caused by skateboarding. In some areas in Hebei, 147 cases of skateboarding-related injuries have been recorded, with up to 63 of the injuries involving teenagers and children, most of whom were beginners and amateurs. The fact that the wrist and forearm are the areas, prone to injury and usually unprotected raises serious concerns (Zhang, 2012). Compared with the West, the development of skateboarding in China is relatively slow, and local research on skateboarding professional clothing and protective equipment is still left behind. There is a dearth of in-depth research on skateboarding functional and wearable clothing because current research focuses on the analysis of skateboarding injuries and their current situation. Hence, this should be given priority, considering that skateboarding is gradually gaining popularity and acceptance among the public. This will not only help improve the safety and comfort of skateboarders but also promote the steady development of skateboarding in China.

1.2 Research Content

The focus of this research paper is to analyze the mechanism, injury site, and degree of fall experienced by skateboarding enthusiasts. It seeks to explore the most vulnerable and often disregarded aspects of the sport and to propose relevant designs and ideas for wrist protection. Firstly, to provide a theoretical basis for the subsequent research a review of the mechanism of falls, the overall situation, and types of injuries due to skateboarding. Secondly, to summarize the advantages and disadvantages of existing products in the current market, market research was conducted on skateboarding wrist. Also, perform online and offline research to determine the relevant situation surrounding skateboarding enthusiasts. Then, summarized the analysis and found out that skateboarding enthusiasts fall mainly because of their low skill level. They usually fall forward or backward and use their hands to support their body from falling to the ground, which can result in injuries. Most of the injuries were experienced by beginners or amateurs who were not satisfied with the existing wrist gloves available from the market. Finally, to prevent a catastrophic situation, various protective gloves were proposed with the integration of aesthetic designs and idea modifications on skateboarding gloves.

1.3 Research Purpose

The aim of this study is to design products to protect the wrist, which is the most neglected part of skateboarding. Skateboarding is a variety of complex movements that involve flexibility and a higher degree of coordination of the human body parts. Skateboarding is a risky and exciting sport, regardless of the experience level, whether novice or veteran. Even the most skilled skateboarders can not escape from the "fall" of the magic grip. In the case of wrong movements, one may easily get hurt, and to some extent, it will have a psychological impact and reduce the skateboarder's enthusiasm. The purpose of this paper is to improve the design of protective gear for skateboarding by focusing on the most commonly ignored and most easily injured wrist part. Thus, skateboarding enthusiasts will reduce their worries about being injured.

1.4 Research Population

The main research subject of this paper targets skateboarding enthusiasts, particularly beginners and amateurs. This group of people generally lack professional guidance and have low skill proficiency in skateboarding. Without the assistance of experts and a lack of professional training, the coordination in the skateboarder's human body is often low, which increases the risk of accidents such as falls. In order to gain a deeper

understanding of this group's needs and characteristics, this paper selects skateboarding enthusiasts among college students as the research subject. These students are at the age of vigor and full of exploratory spirit. They are passionate about skateboarding but often face various challenges due to their lack of experience and skills. In order to collect data comprehensively and objectively, this paper adopts a combination of online and offline research methods. By distributing questionnaires, we collected a total of 216 valid data. Among these respondents, there were 137 boys and 79 girls, and their age groups were mainly between 15-30 years old, the majority were young people between 15-25 years old.

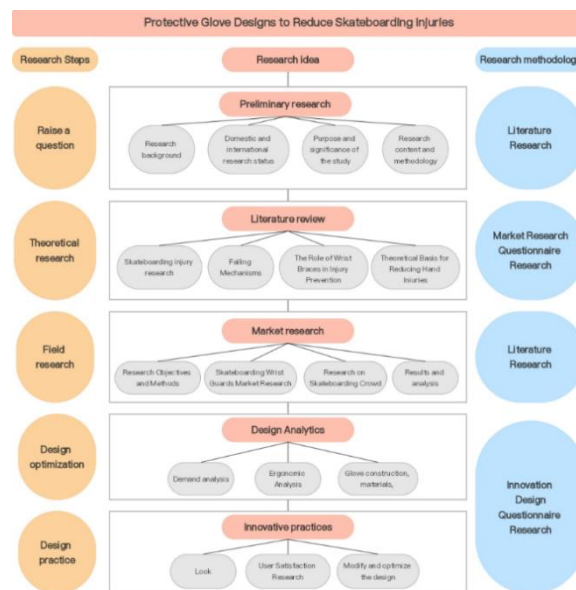


Figure 1: Frame diagram

2. Literature Review

From the viewpoint of domestic academics, a search with the keyword skateboarding injuries reveals that although skateboarding entered China relatively late, it has attracted the attention of scholars in China due to the high number of skateboarding injuries. Teng Shuqing analyzes the types and causes of skateboarding injuries and proposes corresponding effective reduction and avoidance of sports injuries (Teng, 2001). Zhang Qian took college students of Xinjiang University as the research subject, used the questionnaire survey to study skateboarding injuries, and concluded that in the composition of the injury parts, the most injuries above the waist are fingers, wrists, forearms, and elbows, and analyzed that this is due to the complexity of the skateboarding technical movements, which is in line with Zhang Lifeng's viewpoints (Zhang, 2012). Chen Yajin researched the two-wheeled skateboarding injuries of children in the community, and the number of injuries accounted for 62.3% of the total number of injuries, and stated the causes of skateboarding injuries and put forward the corresponding preventive countermeasures (Chen, 2012). Shi Feng took adolescents as the research subject, studied the aspects of skateboarding injury rate, skateboarding injury type, and so on, and came to the conclusion that the average injury incidence rate of adolescent skateboarding reached 46.97%, among which the wrist movement injury rate was listed as the first one and reached 15.64%. He also pointed out that the injuries of skateboarding enthusiasts often occurred in the early stage of skateboarding practice when they just started skateboarding. He proposed that wearing protective gear during skateboarding is very important (Shi, 2015). Yang Shun took skateboarding enthusiasts in Urumqi City as the research subject to study the sports injuries encountered during skateboarding, analyze the causes of their sports injuries, and propose rehabilitation training as well as sports injury intervention (Yang, 2021). In the form of a literature

review, Wangyong Li studied that most skateboarding injuries are fractures of limb bones and sprains of wrists and ankles. However, the injury rate of the head is also extremely high, and proposed that it is necessary to wear good sports protective gear during skateboarding (Li, 2023).

Keilani, a foreign scholar, took skateboarding enthusiasts as his research subjects in the Vienna area and came up with the conclusion that 97% of skateboarding enthusiasts had suffered at least one injury, with serious injuries comprising 45%. Among those who experienced at least one serious injury, 16% of the injuries were to the forearm/wrist/hand. It was found in the course of the study that only 13% of skateboarding enthusiasts wore protective gear (Keilani, 2010). Brian's study also mentions that injuries usually result in wrist and forearm fractures and that skateboarding and snowboarding injuries are higher than rollerblading injuries (Brian, 2016). Kristin's research formulation understands that head trauma accounts for approximately 3.5%-13.1% of all skateboarding injuries. Injuries most often occur in the upper extremities 55%-63% of the time, while thoracic, abdominal, and spinal injuries account for 1.5%-2.9% of all traumas, and lower extremity injuries account for 17%-26% of all injuries. Not only that, upper extremity fractures account for 32.1% of all fractures. During a fall, the combination of speed and extreme force is transferred to the inflexible limb, and due to human inertia as well as physiological reactions, the first thing that happens is to brace the ground with the hand, which usually results in radius/ulnar fracture. It is further noted that upper extremity injuries to the elbow and wrist frequently occur when protecting the head and face out of instinct during a fall (Kristin, 2015). Lara derived from the analysis of data on hospital admissions due to skateboarding that 95% of skateboarders suffer sports injuries due to unskilled movements, with male patients accounting for 73.9% of these patients (Lara, 2016). Francesco overviewed the characteristics, outcomes, and risk factors for off-skateboarding injuries and suggested appropriate risk management (Francesco, 2018).

Scholar Erica conducted research on the wearing of protective gear by adolescents during skateboarding and found that adolescents wore much less personal protective equipment (PPE) than recommended, noting that skateboarding is much more serious than inline skateboarding in terms of injury levels but that 54% stated that nothing would convince them to wear protective gear. The article states that 68% of the reasons for not wearing protective gear were because it was uncomfortable, and 21% were due to appearance (Erica, 2008). Greenwald looks at the mechanism of skiing falls and states that the action of a person falling is to fall backward and that distal radius fractures may persist in an extended arm/hand fall, injuring the wrist, and makes it clear that a wrist protector reduces injuries to the hand, wrist, as well as the forearm. Although wearing a wrist protector can make wrist injuries three times less likely to occur, the use of wrist protectors has not been widespread (Greenwald, 2013). Kern used the psychological predisposition to risky behaviors associated with skateboarding injuries as a starting point to study skateboarding as an individual factor related to risk perception and risk-taking behaviors and further stated that sensation seeking was the only significant factor related to risk perception (Kern, 2014). Thomas, according to the results of his study, showed that only 7.2% of patients skateboarding on surface streets wore a brace and that there was a significant relationship between the rate of skateboarding injuries and the wearing of a brace, and suggested that being in a specific skateboarding area and wearing a brace was effective in decreasing the incidence of injuries (Thomas, 2010). Modelski stated that over 90% of wrist fractures are caused by falls with an outstretched hand caused by a fall with an extended hand and explained a diagram illustrating the pressure distribution in the hand during a fall. This diagram shows the pressure distribution in the palm region of the hand during a forward fall and identifies the magnitude, location, and distribution of pressure in the palm region of the hand for a forward fall (Modelski, 2019). Tuckel's article states that the number of skateboarding

injuries entering the emergency room changed significantly after 2000, with an increase in the percentage of injuries sustained in the street or on the highway, and is based on the observation of athletic injuries at skateboarding parks Rodrigo analyzed the epidemiology of skateboarding, using professional skateboarders as subjects to gather information on injury mechanisms, types of falls, and preventive measures to reduce the number of injuries during training and competition (Hunter College-City University of New York, 2019). Reducing the number of injuries during training or competition so that amateur skateboarders can effectively practice injury prevention (Rodrigo, 2021).

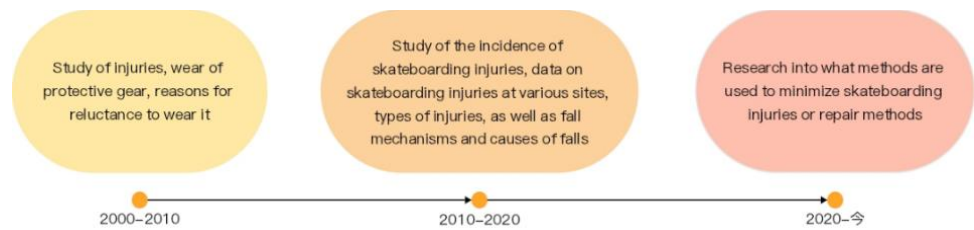


Figure 2: Summary of Skateboarding Situation Study Phase Characteristics

Through literature analysis, current research has extensively covered a wide range of aspects, such as the incidence of skateboarding injuries, injury sites and their types, fall mechanisms and causes, and skateboarding protective gear. However, although considerable progress has been made in the study of skateboarding injuries, relevant literature specifically focusing on protecting the wrist area still appears to be scarce. The current research mainly stays at the theoretical level. It puts forward some suggestions for reducing skateboarding injuries. However, few in-depth studies on the parts of the wrist that are vulnerable to injuries and neglected, and from the perspective of reducing skateboarding injuries, no large-scale research has been carried out yet, especially in terms of product design. Although there are some skateboarding products on the market, the number is relatively small, especially those that can effectively protect the wrist. With the popularization and promotion of skateboarding, the potential hazards caused by skateboarding injuries are becoming more prominent, which makes us more concerned about how to provide skateboarders with more comprehensive and effective protection. Therefore, based on the research results of skateboarding injuries domestically and internationally, and in light of the sport’s rapid development, this paper carries out the design of protective clothing products, especially for the wrist part which is prone to injury and often neglected in skateboarding. Hence, this research is of great significance to the direction of skateboarding protection products.

Table 1: Summary of Literature Features

Research Direction	Authors And Papers	Trait
Analysis of skateboarding injuries in different regions	Keilani, M. (2010)	To study the types of skateboarding injuries, injury sites, and causes of injuries among skateboarders from different regions and populations.
Analysis of skateboarding injuries in adolescents and children	Zhang, L. F. (2012) Shi, F. (2015) Lara, B. M. (2016)	
Analysis of Skateboarding Injuries in College Students	Zhang, Q.(2012) Yang, S. (2021)	
Analysis of the causes of skateboarding injuries	Brian, H. N. (2016) Kristin, M. S. (2015) Li, W. Y. (2023). Teng, S. C. (2001)	The specifics of the injury were studied to derive the most severe areas of injury, the cause of the fall, and the wearing of protective equipment

	Chen, Y. K.. (2012) Francesco, F. (2018)	
Mechanisms of human locomotor falls	Greenwald, R. M. (2013) Godzinski, C. (2019) Tuckel (Hunter College-City University of New York. (2019) Rodrigo, M. S. A (2021)	Mechanisms and first physiological responses to human motion falls, and points of emphasis for hand injuries
The Psychology of Risk Behaviors Associated with Skateboard Injuries	Kern, L. (2014)	Psychology of risk behavior, collection of mechanisms of injury, reduction of injury.
Skateboarding Wearing Protectors and their Injuries	Erica, K. L. (2008) Thomas, L. (2010)	Data on the wearing of protective gear, reasons for not wearing protective gear.

3. Market Research

3.1 Subjects and Methods of Research

This paper takes skateboarding enthusiasts as the research subject. Of the number of people who received the questionnaire, there are 216 people aged 18-30, mostly 20-25 years old, of which college students accounted for a larger proportion in the research process. These young people have different levels of experience and skills in skateboarding, but they all have a strong interest in skateboarding. Through the questionnaire research, we not only understand their actual needs and troubles in skateboarding but also analyze their psychological characteristics and behavioral habits to provide strong support for the subsequent research and design.

Research Methodology:

Literature research method: Through the China Knowledge Network, Wanfang Data, and the school library, a large number of skateboarding and its injuries, skateboarding protective gear, and other related information, collection, collation, and summarization provide a theoretical basis for the study of this paper.

Market research method: Through online and offline research on existing domestic and international skateboard protective gear brands and materials in the domestic market, summarize and analyze the characteristics of existing products and market demand.

Questionnaire research method: The majority of Skateboarding enthusiasts are young people who communicate and organize activities on social networks. In order to better access the research samples, this paper adopts the questionnaire research method. The research subject comes from the members of the skateboarding club in the school of the researcher as well as schools of college students whose hobby is skateboarding. A total of 216 research subjects participated in the survey, and the edited "skateboarding research" was gathered through QQ, WeChat, and so on. The APP obtained a total of 216 questionnaires, of which 211 were successful, giving an effective rate of 97.68%. According to SPSS 25 analysis reliability statistics for 0.85, indicating that the questionnaire reliability is good.

3.2 Skateboarding Wrist Guards Market Research

The core function of wrist guards is to provide solid support and protection for the wrist, effectively reducing the external force and pressure on the wrist joints by enhancing support and stability, thus protecting the safety of the athletes. In recent years, skateboarding equipment has been highly sought after. With the growing popularity of skateboarding culture and parents' support for their children's sports hobbies, it is expected that more parents will buy skateboards and related accessories for their children in the future, a trend that will undoubtedly continue to heat up. According to statistics, the average American family spends up to \$390.00 per year, of which \$109.00 is dedicated to skateboarding equipment. According to research data on the skateboard protective gear market, the global street skateboard accessories market has reached a size of \$23,005,000,000 in 2021. It is expected to continue expanding in the future. The market size is expected to grow further through 2030, while the Compound Annual Growth Rate (CAGR) between 2022 and 2030 is projected to be 3.91%. These figures not only highlight the prosperity of the skateboarding market but also signal a broader market outlook for skateboarding protective gear products, especially key accessories such as wrist guards.

The popularity of high protective gear brands, their materials, styles, design details, and other aspects of the summary of statistical research was indicated in the skateboarding domestic and international markets.

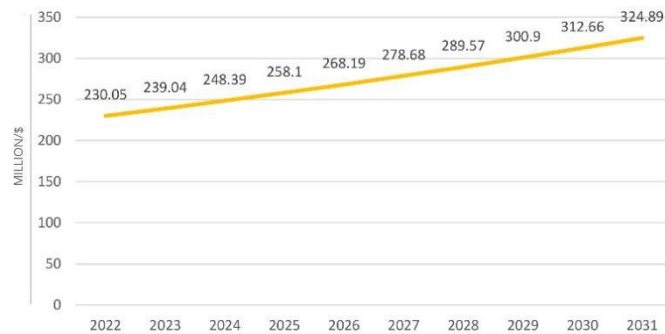






Figure 3: Growth rate of skateboard protective gear

source: <https://straitresearch.com/report/street-skateboards-accessories-market>

Table 2: Summary of skateboard protective gear brand research

Branding	Materials Technology	Detailed Design	Product Pictures	Trait
187 killer pads	EPS foam protection layer SWEATSAVER· comfort and wicking textile· MIPS technology	Adjustable Velcro at the wrist and abrasion-resistant fabric throughout		buffer
Top Domrus	High-quality PE plastic shell· Highly flexible lining 900D nylon fabric	Velcro adjustable		buffer
Decathlon	Quick-drying fabric PC polycarbonate material	Velcro design Ventilation hole design lightweight		buffer
Other Brand	Normal Friction Fabrics	Gloves & Protective Gloves Combination semi-exposed fingers		buffer

In summary, we have conducted in-depth research on the well-known skateboard guard brands on the market, such as 187 Killer Pads, Top Domrus, Decathlon, and other brands of protective skateboard gloves. After analyzing the materials, design details, and features of these products, we found that although most skateboarding wrist guards use high-quality plastic shells in the palm position and effectively cushion the impact of a fall through the external plastic shells and the internal protective layer, this design mainly focuses on the protection of the inner part of the palm.

For the wrist area, most of the current protective gears are simply fastened to the wrist by means of Velcro, which has a relatively weak protective effect. During skateboarding, the wrist is often subjected to great pressure and impact. However, the existing design of the brace does not really take into account the comprehensive protection of the wrist. Therefore, it is necessary to conduct more in-depth research and design for the wrist area to provide more comprehensive and effective protection to ensure the safety of skateboarding enthusiasts.

3.3 Results and Analysis

The survey shows that the average incidence of sports injuries among skateboarding enthusiasts is 97.68%, and the incidence is mostly concentrated in beginners. The above data suggests that beginners do not prioritize wearing protective gear during the course of the sport and find reasons for not wearing protective gear.

3.3.1 Prevalence of Injuries Among Skateboarders

According to the research results, the average probability of skateboarding enthusiasts sustaining injuries during the sport is as high as 97.70%, with the beginner group being the most prone to injuries. Many beginners do not wear protective gear as a priority during the sport, which leads to a higher risk of injury when skateboarding. After an in-depth investigation, we also found that there are many reasons why beginners do not wear protective gear, which involve safety awareness, comfort and convenience of the gear, and other aspects. Therefore, it is necessary to strengthen the popularization of skateboarding safety education for beginners to enhance their awareness of protection, and at the same time, it is also necessary to design more skateboarding characteristics, comfortable and easy-to-use protective gear products to provide skateboarding enthusiasts with more comprehensive protection.

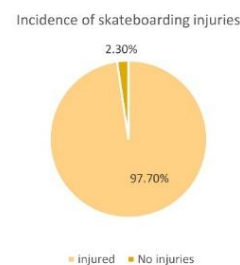


Figure 4: Figure 4: Incidence of skateboarding injuries

Source: Author's research statistics

3.3.2 Sites and Types of Injuries in Skateboarders

The main parts of the sports injury of skateboarding enthusiasts are the elbow joint 78.2%, wrist 66.2%, hip 65.3%, shoulder 44.9%, knee 31.9%, and back 30.1%. The main reason for their fall is in the process of skateboarding skating; skateboarding enthusiasts are not skilled, which leads to body imbalance. At this moment, the body's instinctive reaction will be to use the hand to hold the ground and the wrist to absorb the pressure of the fall, thus increasing the rate of distal radius injury. In addition, there may also be a

case of backward support for the arm palm. Due to the beginner's lack of awareness of the body balance, there will be a "sitting" fall, with the buttocks landing first and so on, resulting in the injury of various body parts.

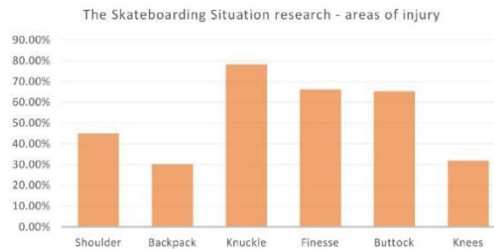


Figure 5: Sites of injury in skateboarding
Source: Author's research statistics

The main types of sports injuries by skateboarding enthusiasts are abrasions 65.3%, joint sprains 57.9%, fractures 51.4%, and ligament strains 44.9%. It is worth noting that fracture-type injuries accounted for 52.61%, which indicates that during the skating process, skateboarding enthusiasts do not reasonably wear protective gear. This type of injury is very serious to the athlete and may cause permanent disability. Therefore, wearing appropriate protective gear is particularly important when skateboarding. However, the procedure of collecting and organizing data did not get satisfactory results.

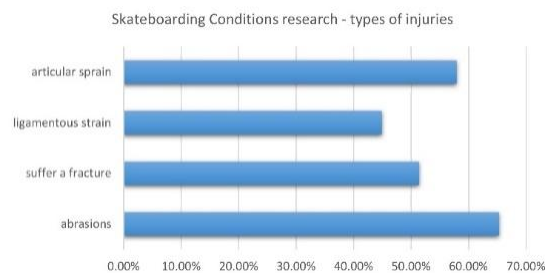


Figure 6: Types of skateboarding injuries
Source: Author's research statistics

3.3.3 Wearing of Protective Gear by Skateboarders

According to research, a whopping 63.0% of skateboarders choose not to wear protective gear for various reasons. Among them, 52.8% think that protective gears are not comfortable enough to wear, 42.1% because they are made of too hard materials and may still cause injuries in case of a fall, and 38.9% feel that protective gears will affect their skating maneuvers. In response to these research data and the market research mentioned above, we should work on designing protective apparel that satisfies users to enhance the safety of skateboarders and enable them to enjoy the fun of the sport while being adequately protected.

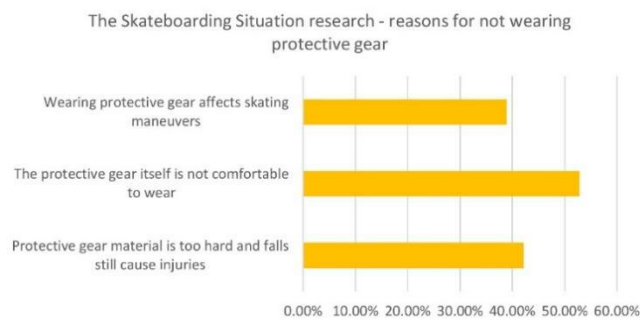


Figure 7: Reasons for not wearing protective gear in skateboarding
Source: Author's research statistics

3.4 Summary

Based on the above data analysis, it is concluded that 97.7% of skateboarding enthusiasts fell while skateboarding because 78.7% exercise in outdoor skateboarding venues, which is a complex outdoor environment, 62% said that they fell because of the wheels being stuck by small stones, and both skateboarding novices (79.6%) or veterans (38.9%), said that they had fallen during skateboarding. Elbow joints (78.2%), followed by wrists (66.2%) and hips (65.3%) accounted for the highest number of injuries. The types of injuries also vary, with abrasions (65.3%) and joint sprains (57.9%) being the most common types of injuries among skateboarders. Despite the high injury rate, skateboarding enthusiasts who wore protective gear during actual skateboarding were still in the minority (34.7%). It is understood that skateboarding enthusiasts who do not want to wear protective gear believe that the wearing of protective gear is uncomfortable (52.8%), that the material of protective gear still causes injuries to the body after a fall (42.1%), and that the wearing of protective gears affects skating movements (38.9). In conclusion, skateboarding enthusiasts should be provided with protective sports equipment, i.e., protective, comfortable, and aesthetically pleasing clothing and wearable equipment that is compatible with skateboarding.

4. Glove Design Analysis and Innovation Practice

4.1 Glove Design Analysis

4.1.1 Needs Analysis

According to the above research, the main reason for skateboarders to fall is their lack of skill and technique, usually falling forward or backward and holding onto the ground with their hands, which leads to injury. We need to analyze the requirements for this process.

Furthermore, the gloves should provide necessary comfort, safety, breathable moisture, anti-friction, and other basic functions (Chen, 2021). However, they must also serve the function of protecting the wrist. To address the skateboarder's rejection of wearing wrist guards, we have designed skateboarding gloves that integrate protective airbags with intelligent braking. At this stage, young people are more willing to choose protective gear that matches the new wave of popular fashionable clothing (Liu, 2023) to ensure that the protective function is in line with the trend of smart wearable design. That is the style that combines protection, comfort, and aesthetics.

4.1.2 Ergonomic Analysis in Gloves

Ergonomics is the "human-environment-clothing" that achieves a balanced state that makes the user more comfortable and in line with the human body structure.

The wrist is the most easily neglected and injured part during skateboarding. The hand, in the natural state of relaxation, presents a flexed state. In the absence of any force, the muscle groups of the hand maintain a relatively balanced state posture. In this state, the radial ulnar tilt angle is 20°, the palmar tilt angle is 15°, there is a mild ulnar deviation, and the metacarpophalangeal joint and interphalangeal joints are semi-flexed positions (Schilt, 2019). Based on these ergonomic principles, the glove's fit was thoroughly researched and optimized to ensure that the glove would fit more closely to the shape of the hand in a relaxed state, providing skateboarders with more comfort and safety.

Based on our previous research, we found that 78.7% of skateboarders prefer to do their skateboarding outdoors. Skateboarding tricks, such as Shovit, Ollie, Nollie, and other difficult maneuvers, are extremely demanding and affect the body's physical energy. This is not only a test of the athlete's own will and skills but also a double challenge to the external environment and their own physiological functions. In this context, skateboarders have new and stricter requirements for the materials used in sportswear and wearable equipment. The characteristics of skateboarding require us to consider the friction, freshness, comfort, and aesthetics of the final product. These elements are not only related to the actual experience of the athletes but also affect their performance and mood during the sport. Choosing the right materials for clothing and equipment is of vital importance to skateboarding enthusiasts.

4.1.3 Glove Construction, Materials, and Technical Design

The gloves were designed to address a gap in the market for a combination of wrist protection devices as well as skateboarding gloves.

The overall design concept of the gloves is to add intelligent settings to the protective properties of skateboarding gloves by skillfully combining acceleration tilt angle sensors and airbag devices. These gloves not only meet the basic needs of skateboarding enthusiasts for comfort and safety but also excel in perspiration, moisture, permeability, and anti-friction.

In terms of glove materials, high-performance materials suitable for skateboarding are selected. The outer layer of the gloves is made of wear-resistant and durable materials to ensure that the gloves maintain their good appearance and performance over a long period of time. Meanwhile, the inner layer of the gloves is made of soft, breathable fabrics to ensure comfort and perspiration when worn (Chen, 2018).

A single capsule-like structure made of Thermoplastic Polyurethane (TPU) composite cloth was utilized for the airbag material. This material not only has good flexibility and durability but also can effectively cushion the impact and protect the hand from injury. Meanwhile, the raw material of the single-sided adhesive fabric airbag is TPU film laminated in the inner layer, which makes the airbag more stable (Li, 2018).

In terms of technical principles, an acceleration tilt angle sensor is utilized to monitor the skateboarder's movements and posture in real time. When the skateboard takes a fall at a corner, the sensor quickly captures the change in the angle between the person and the ground as well as the magnitude of the speed. Once the preset trigger conditions are reached, the sensor device activates the gas cylinder immediately and releases gas for instantaneous inflation. In this way, the protective airbag is able to inflate automatically at the moment of the fall, providing all-around protection for the hand and wrist (Yang, 2022).

Overall, this smart skateboarding glove, which combines an acceleration tilt angle sensor with an airbag device, not only provides excellent comfort and safety but also realizes a qualitative leap in protection performance. It will be an indispensable equipment choice for both beginners and experienced skateboarders.

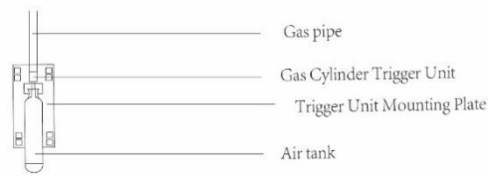


Figure 8: Trigger airbag device
Source: Author's own drawing

4.2 Glove Product Design Innovation Design Practice

The innovation of this design focuses on protecting the wrist by applying airbags to the gloves (He, 2023), resulting in improved protection, increased protection area, and enhanced safety.

4.2.1 Design

Table 3: Summary of skateboard glove design options

Orientations	More compatible design			
positively				
the reverse side				

This article utilizes the Midjourney tool to try to come up with a picture ref. And in the many pictures selected in the more consistent design to summarize a little:

4.2.2 User Satisfaction Survey

I conducted in-depth face-to-face interviews with several skateboarding beginners, and this exchange gave me a more detailed understanding of the psychological state of beginners. When talking about the process of learning skateboarding, they generally said that fear is the most common problem encountered by beginners. Whenever they try a new maneuver, they need to overcome their inner fear and muster up enough courage to take that step. And this fear mainly comes from the fear of falling. Beginners feared that falling would cause pain and possibly even injury, and this fear was roughly in line with the data we collected in the questionnaire.

In addition, I found that many beginners do not know how to protect themselves properly when they fall. They tend to get injured due to incorrect fall positions, sometimes even in the really vital areas. This made me realize that the proper way to fall and the necessary protective products are very important for beginners. When asked if they needed a protective glove that met their needs, their answer was yes. They showed great interest in the gloves designed in this paper and felt that such a product would provide them with better protection.

In a broader group of users, I found that a whopping 61% of skateboarding enthusiasts are novices. Among this group of enthusiasts, 65.3% are not willing to wear protective gear such as wrist guards. This could be because they do not know enough about these products or feel that wearing them will affect their sporting experience.

However, in the survey of "Midjourney Skateboarding Protective Gloves Design Drawing and Its Opinion Modification Questionnaire," it was found that if the design of the product itself can satisfy the needs of users, then 72.5% of the people said that they

are willing to wear such protective gloves, and 53.5% said that they are willing to buy this product. This shows that users are willing to wear protective gear for their own safety as long as the product is properly designed.

At the same time, I also conducted research on the front and back design of the gloves. The results showed that the following two images received the highest votes during this research 37.3% and 32.3% respectively. This provides a valuable reference for us to further optimize the product design.

Through this interview and research, I deeply realize that it is very necessary to design a protective glove for skateboarding beginners to meet their needs. This can not only provide them with better protection but also enhance their confidence and enthusiasm for skateboarding.



Figure 9: Glove front and back satisfaction scheme

31.1% of the reluctant people also collected their reasons: 23.4% of the people think that the price of this smart product will be high. In terms of style; the style is simple yet has a complicated sense of design that is also flat at 15.6%, in terms of fabric; 21.6% of the people are more willing to buy products with moderate fabrics and good ventilation, in terms of the position of the airbag; 19.2% of them said that the position of the airbag is reasonable. 16.2% of the people said they would like to buy this product after the above collection and modification.

Based on the above research and the opinions of the customer groups, the above design has been improved to meet the requirements of the user groups. The following is the re-modification and design drawing based on the comments:

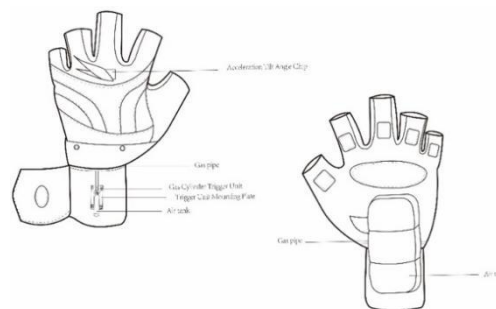


Figure 10: Modified style drawings and design notes
Source: Author's own drawing

4.2.3. Renderings and Design Notes



Figure 11: Multi-angle rendering of the final skateboard glove
Source: Author's own drawing

Design Description:

This design focuses on the wrist area, which is often neglected and easily injured by skateboarders, and aims to provide more comprehensive and intimate protection for them. The gloves are designed with half-exposed fingers, which ensures flexibility and makes it easy for skateboarders to grip their boards during sports. In terms of color, we have adopted the unique style of wasteland wind, with dark and light color block matching and collage design, which not only shows individuality but also meets the aesthetic needs of modern young people.

In the choice of materials, we emphasize the breathability and anti-friction properties of the fabric to ensure that the gloves remain comfortable under prolonged wear. Especially on the inside of the fingers and palm, we have added special anti-friction materials to increase friction and make the grip more stable.

In terms of protection, we pay special attention to the wrist area. An inflatable airbag is used between the palm and the wrist, which provides a strong cushioning effect while guaranteeing dexterity. In addition, the back of the hand is also set up with an acceleration tilt angle sensor. When skateboarders fall at the corner, the sensor will quickly activate the gas cylinder according to the speed and the angle relative to the ground. This will cause the gas to be released, and the airbag automatically inflates to protect the hands and wrists effectively from injury at the time of the fall.

In summary, this glove not only focuses on aesthetics and comfort but also carries out in-depth research and development on protection performance and strives to provide skateboarders with all-around protection so that skateboarders can enjoy skateboarding again and also feel the heart and care in its design.

5. Conclusion

With the promotion and development of skateboarding, it is necessary to enrich and improve the protective products related to skateboarding. This paper utilizes literature research, questionnaire survey, data analysis, and other methods to analyze and summarize the detailed analysis of skateboarding, injuries, and other situations. Skateboarding enthusiast's average incidence of sports injuries is 97.68%, and the majority of the concentration is on beginners, of which the wrist injury rate is 66.2%; the results are basically consistent with other literature. Sixty-three percent of skateboarding enthusiasts do not wear protective gear during sports. The reason is that the protective gear itself is uncomfortable (52.8%), the material of the protective gear is too hard, and the fall will still cause injuries (42.1%), and the protective gear affects the skating action (38.9%). The design of the final skateboarding glove was modified to reflect the existing trend and take into consideration the feedback of the user community. The gloves and protective airbags were combined to provide an intelligent braking system to ensure the protective function and enable more people to try to experience skateboarding without fear, contributing to the development of China's skateboarding movement.

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