



Ergonomic Risk Assessment and Investigation of Outdoor Sports Equipment Designs by User Research

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Abstract

It is aimed to instill movement habits in society and provide healthy exercise to individuals with outdoor sports equipment, which is intended to be accessible to users of all ages of the society. However, when individuals use the products in these areas, incorrect usage and exercise positions performed at the wrong angles may be encountered. The aim of this study is to examine how the designs of exercise equipment in public parking areas guide the user and how they affect the user in terms of ergonomics of use and motivation to exercise. The study showed that using outdoor sports equipment did not cause any significant change in the body by creating a body pain map. The study aimed to contribute to the design of outdoor sports equipment through analysis and observations.

1. INTRODUCTION

One of the most basic human needs is movement. A person's movement occurs next to the most basic needs, such as nutrition, sleep and shelter. Movement keeps people healthy and vigorous, and benefits human physiology. The importance of moving, especially at the point of health, has been proven in many studies done so far. Along with the physical health effects of moving, its positive effects on neural health have been proven by many scientists [1].

The awareness of the importance of movement has created areas where people will move and do sports, and gradually lead people to move and exercise with different types of exercise. In this way, it is aimed at people who can go to these common areas near their homes and can easily use these outdoor walking paths and exercise areas without any membership or fee. For this, walking trails and exercise equipment have been added to the parks, which are built-in places accessible to users of all ages [1].

Since the exercise equipment in the parks is open to everyone's use, it is aimed that users of different ages and dimensional sizes will use these tools. As seen in the observations and literature review, it is known that the users misunderstand some movements and that the exerciser is not suitable for the person, that the person forces his body in positions that may cause disability [2, 9, 10].

This study aims to design sports equipment in public open spaces to guide the user, how it affects the user in terms of ergonomics, how the motivation points for exercise are reflected on the user, and to provide an opportunity to improve the designs of outdoor sports equipment in the future.

2. DESIGN DETAILS OF OUTDOOR SPORTS EQUIPMENT

First, some findings regarding designs were obtained when the exercise equipment in open areas was examined. For example, user directions could be more comprehensive and more easily understandable. Although the visuals on the signs placed in some parks show how to do the movement, users may need to see these signs and may start using the exercise device directly. In such a case, the product is expected to guide the user with its design [11]. This is because 71% of the users who participated in this research declared that they did not know how to exercise. Likewise, 53% of users stated they needed help understanding the instructions on the outdoor sports equipment.

In addition, tools tend to move and rotate uncontrollably. While there is a possibility of misuse by the user who cannot get enough guidance about usage, it is possible to make uncontrolled and sudden movements in this case. The reason for this inference is that approximately 80% of the participants stated that they were afraid of falling while using outdoor sports equipment and therefore felt insecure. For this reason, there is an unconscious use of tools, which poses a danger.

Another subject examined is the materials used in exercise equipment. Materials that can be used in summer and winter, suitable for open space and provide ease of use should be considered for these products. Factors such as rainwater or snow accumulation should be considered because these deposits can make it challenging to use exercise equipment and create safety problems. Accumulations may form in closed footsteps and are designed hollows, or when the snow accumulated on the footsteps comes together with the plastic material, it can turn into a slippery and dangerous stepping area. This is because 78% of the participants said they do not use outdoor sports equipment in adverse weather conditions. 52% of the participants who expressed negative opinions stated that this was the effect of iron and similar metal materials on body contact areas in extreme cold and heat. Especially in movements with a moving platform, such risks should not be taken for the user's health.

3. THE RELATIONSHIP OF OUTDOOR EXERCISE TOOLS DESIGN-ERGONOMICS

Anyone who wants can use the exercise equipment in the parks. Looking at the world in general, the number of these areas, which are places where users can quickly come and do their daily sports activities, is increasing.

For this reason, it has become clear that the tools used in today's conditions must be designed according to ergonomic rules, not negatively affecting users. Otherwise, the product designed against ergonomic rules needs to provide ease of use for the user.

In terms of the relationship between exercise habits and ergonomics, the ergonomics of outdoor sports equipment directly affects the exercise performed. Ergonomically well-designed equipment helps users maintain correct form while exercising, which reduces the risk of injury. At the same time, it increases the likelihood that users will use this equipment regularly. Non-ergonomic equipment can increase the risk of injury to users, reducing their desire to exercise. Exercise habits and ergonomics in outdoor sports equipment are complementary elements that play an essential role in increasing individual's general health and fitness levels. Existing literature shows that well-designed outdoor sports equipment improves users' regular exercise habits and general health. At the same time, it is emphasized that ergonomic design increases the user experience by reducing the risk of injury. Therefore, giving importance to ergonomics in the design of outdoor sports equipment is critical to ensuring that users exercise safely and effectively.

When the sports equipment designs are examined, as a requirement of ergonomics, the user is expected to increase their mobility without physiological strain [3].

For this reason, exercise equipment designs should be designed in a way that is easy to understand and does not cause injury. For this, it is of great importance that it is ergonomic. The exercise equipment designed without considering the different limb sizes of the people will cause the body to be forced

incorrectly and cause injury. As a design improvement, 59% of users stated that the handle and grip points were unsuitable. In this case, the holding and grasping points must be shaped to prevent slipping.

64% of the participants stated that outdoor sports equipment's resistance levels were unsuitable for them. This is because the impact areas of these tools were made for standard users, and it was observed that the impact areas of small and large age groups were ignored. This situation causes a decrease in the sustainability of product use [4].

The first boundary condition in the design of sports equipment is to know the anthropometric data of the users. The anthropometric data of the target user group should be taken as a reference for ergonomic design in the design of the products with a user-oriented approach [5, 6].



Figure 1. Use images of various outdoor sports equipment

According to the answers from users, ergonomic and climatic conditions are not considered in the design of outdoor sports equipment; it seems that general measurements are taken as reference. This situation harms usage [12]. However, it has been observed that users with different body sizes use these tools during use. The reason for manufacturing with standard size may be ignoring the necessary scientific ergonomic rules starting from the design or the cost factor coming to the fore during manufacturing. Problems arising from this situation cause injuries, which will be discussed in the next section. In addition, it has been observed that the region's climatic conditions are also necessary. Because sports equipment is constantly exposed to natural events such as sun or rain, snow adversely affects its use.

In terms of ergonomics, the aim was to evaluate the products as suitable for the user and to design them according to the user's anthropometric data [7].

The expression of ergonomics has positive effects on the performance and productivity of the users, and it is aimed to reduce the unnecessary strain on the user during sports. To create the most efficient environment for the user, handling the sport by the physical, physiological, and anatomical dimensions of the user; the fact that the designed product is related to the user's physical capabilities is among the functions of the ergonomic concept because it is only in this way that the person can get efficiency from the exercise they do [8].

When the products used by the users for sports purposes are made suitable for ergonomics, the physical deformations of the users due to sports activities are reduced. However, otherwise, users may experience physical discomfort. In addition, if the products that are not designed according to ergonomic rules are not suitable for use, the product will not be demanded by the user. This situation could be economical as it will be an unused product and inactive raw material for the future [3].

4. INVESTIGATION OF THE USER RELATIONSHIP WITH THE DESIGNS OF OUTDOOR SPORTS EQUIPMENT

Considering that many open spaces are parks and exercise areas, the design of these exercise areas is very importance. With the changes to be made to the design, essential touches that will increase the users' life quality will be possible [13]. For this reason, this research aims to determine the problematic points by learning the users' habits and thoughts on these areas.

The research method chosen for this data, which is planned to be found, is a survey. By contacting the users one-on-one, information was collected about their exercise routines in these exercise areas and their perception of these devices. The sample of this research aimed to reach a group that actively uses these areas. For this reason, the park areas were visited, the individuals already exercising there were selected, and a survey was conducted.

Since the design in question has an impact on exercise areas and health, interviews were held with health and sports scientists about whether these designs in exercise areas are suitable for their purpose and whether they will provide healthy exercise. Here, too, data were obtained from experts on the efficiency and effects of these tools. The aim here is to obtain data on injuries that have occurred or may occur up to now with the use of these instruments.

5. INVESTIGATION OF EXERCISE CONSCIOUSNESS AND HABITS OF INDIVIDUALS USING OUTDOOR SPORTS EQUIPMENT

It was collected by survey and face-to-face interview method with 50 users.

Table 1. Age distribution of participants

Age	Participant
20-30	16
31-40	13
41-50	6
51-60	5
61-above	10

In the survey, the users' habits of using the parking areas, their discomfort, the pain they experience while using the exercise equipment, their perception of the exercise equipment, and their comments on the efficiency of the equipment, and the frequency of use were examined. This section it is aimed to collect data about the problems experienced by the user while doing sports in the exercise areas and their exercise routines.

In this study, individuals who use outdoor sports equipment, the frequency of use of these equipment, whether they have enough knowledge about exercise and sports, and injuries and injuries related to exercise were examined.

In order to measure the efficiency and usability of outdoor sports equipment and to see how it is evaluated by users, a questionnaire was prepared for a group of 50 people from different age groups on how they use and position the exercise equipment.

Within the scope of the research, the answers received when the participants were asked about their knowledge of exercise and sports are as follows.

Table 2. Level of knowledge about exercise and sports

Level	Ratio
Very Well	1%
Good Well	9%
Intermediate	40%
Low	28%
Nothing	22%

When we look at the answers given above, it is seen that more than the users' interest in sports is needed. Since the participants need to learn how to use their bodies correctly, they do not exercise at the required intensity. They cannot do sports fully and correctly because they need to know the working logic of the exercise equipment and how the effects should be on the body.

When the answers to some critical determining questions in the survey are examined, While 97% of the group expressed positive mental feedback about exercising, 59% stated that the tools were insufficient, and 69% needed to know which muscles the tools worked on and which areas they addressed.

We see that 49% of the participants need to learn which areas the tools operate and what they do.

We see that 58.4% of the participants need to learn how to use these exercise tools for their goals. For this reason, a conscious guiding person or directive should guide users in this regard.

We see that 47% of users wonder whether these tools work correctly..

Most users feel pain in the knee, hip, shoulder, neck and waist joints. These pains pose a threat to the physical health of the individual, as incorrect and intense loads on the joint areas can lead to consequences such as disability.

Users need to learn how to exercise in these areas, and they find the information given by the directions insufficient when making applications. Even if users exercise, some pain occurs in the joint areas, and occasionally, they doubt whether they are working correctly. In addition, even if they complete the sport, they may not get productive results because they need to know whether their exercise suits their purpose.

5. CONCLUSION

The first thing to draw attention to in the data collected in the study is that the level of user awareness could be higher. Surveys and interviews show that users can be loaded on the joint areas and injure themselves in the wrong forms with sufficient knowledge.

Table 3. Comparison of body pain regions

REGIONS	DAILY LIFE	WORKING ON SPORTS EQUIPMENT
Neck	%29,5	%12,5
Shoulder	%34,1	%37,5
Waist	%52,3	%43,8
Wrist	%9,1	%9,4
Fingers	%6,8	%9,4
Hip	%22,7	%28,1
Knee	%54,5	%43,8
Ankle	%25	%25
Toe	%6,8	%9,4

As can be seen in the comparison of body pain zones, the exercise they do in parking areas did not benefit their daily pain and significantly effect on the level of pain in these areas. In other words, the tools the users use while performing sports activities in public places are must be more suitable.

The reasons why outdoor exercise equipment could be more effective are detailed below.

Leg Strengthening Machine:

There is no option to adapt the device to the body. For this reason, users may work from the wrong angles without realizing it. Forcing the body to carry loads in the wrong position may cause injuries or cause knee and waist problems in the future. In addition, the person is expected to attach his ankles to the iron and lift himself. Here, the resistance applied to the legs may be too heavy for some users and light for others. In addition, problems may arise due to height differences. The iron may remain higher on some users' wrists than others. This will cause the load to be placed differently, and the leg muscles will not work actively and correctly.

Waist Stretcher:

The device could be more robust in terms of control and balance. It can disrupt a person's control mechanism. Possible falls and injuries may occur. Hand grip alignment may only be suitable for some users. An upright posture must be maintained during the exercise, but no element can guide this. Uncontrollability may lead to hip and waist problems in the future.

Bicycle Tool:

The device is inspired by a bicycle, but it is made of metal and can be moved for a prolonged period. It is difficult to use the pedals because they do not hold the foot well enough, and slipping and falling may occur. Since the length cannot be adjusted, waist and neck problems may happen in the long run. If used by a tall user, excessive knee flexion may cause knee problems in the future.

Body Building Equipment:

The product can be considered as an equivalent of the chin-up movement. This movement aims to carry one's body weight and is unsuitable for all strength levels. Each individual's strength level may need to be increased to lift their body. Lifting with the wrong grip in this movement carries the risk of serious injury to the shoulder, spinal cord, and back muscles. This may be triggered by the arm grip distance not being entirely suitable for bodies of all sizes. It can be a risky exercise, especially for the older adults.

Inner and Outer Leg Strengthening Device:

The device focuses on the coordinated work of the arms and legs by moving back and forth. However, since this movement flow progresses very limitedly way on a single axis, it is very susceptible to

disrupting the user's balance. Since the grip of the footrest does not stabilize the foot sufficiently, the angle of the legs may become too broad due to loss of control, and possible injuries may occur.

Elliptical Bike:

The elliptical movement inspires the device. In the movement, the legs draw ellipses in coordination while the arms move back and forth. Considering individuals of different heights using this tool, the ellipses that the legs will turn will be of various sizes, and their angles will also be different. Besides, it is uncontrolled. It is open to possible falls.

Shuttle Machine:

The machine is based on crunches and reverse crunches. However, since the anchors are fixed in place, they may become unusable due to height differences. Moreover, it may cause injuries when used by people who do not know the angle is incorrect. However, the level of the reference part where the person's back should descend during the sit-up requires a deep opening and closing from the abdomen. Although this angle is unsuitable for all levels, it can lead to injuries.

Arm and Shoulder Exercise Device:

The device focuses on providing arm and shoulder joint mobility by rotating the discs with the arms. It can be interpreted as a successful tool based solely on joint mobility. However, since the angles will vary for users of different sizes, fully efficient movement may only occur for some users.

The same problems have been observed with other outdoor sports equipment. In this situation, public parking areas in residential areas should be well-designed to contribute to the users' health. It has been seen that presenting the sports activities of the users in their daily lives as safe and ergonomically safe, regardless of their age, is essential in terms of body physiology. When the designs were examined, it was seen that they were dimensioned according to the average user dimensions. This makes it difficult for users with different sizes to use. Mechanized solution proposals can be used effectively by users with other dimensions.

Redesigning the instruments with the body pain percentages presented in this study will reduce the physical deformations of the users. In this way, harmony between the product and the user is ensured, and as a result, the tension on the user will be reduced. Thus, the phrase "the task must be compatible with the user," which is frequently repeated during the design training, is applied.

It has been determined that the products do not give feedback on the correct use by the user during use. The user continues to misuse the tool, and as he receives no feedback, he will realize that he needs to use the tool correctly. This is another point that needs to be added to guide the user.

Another issue reached by collecting data is that exercise tools need to motivate users to exercise. There are unforeseen product deficiencies related to seasonal conditions and material selection. Examples of this are the accumulation of water in the footsteps or the slipping of these parts when snow; the parts to be held can get very cold because they are metal, and the areas that will come from the waist and back are hard-to-use units in the form of metal strips and the associated squeaking is an example. It is not possible for users to exercise safely and efficiently on these devices under these conditions. This has a large negative impact on their motivation to exercise in these areas.

In light of all the data obtained in the study, it was stated that the park exercise equipment was not designed with ergonomics in mind, and changes were needed to selecting materials. It has also shown that the design details should be designed to make the user feel safe, guide them correctly, and increase their motivation for exercise.

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