Research Paper:
Investigating the General Safety of Playground Equipment and its Compliance With National Standards

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ABSTRACT

Background: Accidents caused by children's play equipment are a severe health threat to them. Implementing the requirements of the safety standards is necessary to ensure the safety of such equipment. The current study aimed to determine the general safety of playground equipment in general parks in Gonabad City, Iran. We also compared the level of the general safety of this equipment with national standards.

Methods: This cross-sectional and analytical study was conducted in all the parks of Gonabad City during the autumn and winter of 2017. The required information on the playgrounds in the public parks of this city was collected by a checklist. The checklist was designed based on the general safety of playgrounds standards (national standard 1-6436) in 124 items.

Results: On average, 9.55 of standard requirements were not implemented in examined parks. Moreover, none of the studied parks fully complied with current standards. We observed fractures, cracks, or deformation in equipment, rough surfaces with the risk of injury, hazardous conditions due to inappropriate design that could harm children, as well as the lack of middle aggressors. These were non-compliant components observed at least 70% of the studied parks.

Conclusion: Removing points with fracture and defective points, and improving the level of children's playground is essential. The obtained data also emphasized the need for periodic safety audits and the improvement of the safety level of children's playground equipment.

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Introduction

Safety and accidents caused by children's play equipment majorly impact their biopsychological health. Accident-related injuries are the leading causes of disability, permanent abnormality, and death in children [1, 2]. Currently, the concept of health and safety research is more commonplace for industries and working environments; however, there are indoor and outdoor places that are potentially harmful to children. Parks and playgrounds are among these important places for children. Undoubtedly, the children's safety in such places depends on the safety of the play equipment. Playgrounds, while increasing the intellectual, emotional, biosocial, and creative activities of children, should provide a healthy and safe environment for them. However, the statistics of accidents caused by unsafe equipment of parks and playgrounds are considered as a serious threat to the children's health [3].

The American Products Safety Commission reported 147 death cases of children aged <15 years due to playground equipment in 2000. Furthermore, every 2.5 minutes, a child is injured in playgrounds [4]. According to Vollman (2009), in the United States, about 211000 children are annually referred to the emergency department due to accidents involving playground equipment [5]. In many countries, including Iran, extensive studies have been conducted on industrial events, as well as their effects and causes [6-10]. However, in Iran, due to the lack of valid documentation on accidents involving children's play equipment in parks, it is impossible to use the results of the analysis of events after their occurrence to prevent their occurrence. The lack of maintenance of parks' equipment is among the causes of accidents in these places. This issue has caused the risks of moving, running, and walking on the playgrounds' floor. Other factors, including brightness and lighting, may also affect accidents [11].

Despite the possibility of preventing children's happenings in playgrounds, in most parts of the world, including Iran, policymakers and health providers are less concerned about the safety of children playgrounds. In this regard, preventing child injuries is a major responsibility that requires the commitment and full participation of a wide range of government officials, municipal organization, national standards organization, families, and even children. Therefore, the safeties of these environments, which are somehow a social work environment, should be among the priorities of organizations involved in this issue. Children are highly energetic and are unaware of the potential risks that threaten them. It is a heavy responsibility for those involved in equipping and preparing recreational services. Providing stable and qualitative conditions for parks to improve the level of safety and health of children initially requires the establishment of appropriate physical conditions and the construction of play equipment based on safety principles. Improving the safety and quality of equipment also requires compliance with standards. Currently, no organization is responsible for periodically evaluating the safety of children's play equipment.

Generally, the process of building and installing children's play equipment in the public parks must comply with the standards for equipment developed published by the Institute for Standardization and Industrial Research of Iran. Such protocol is provided to the constructors of this equipment. Moreover, manufacturers are required to design children's play equipment based on the latest available standards. The standard certificate will be issued for this equipment after complying with the relevant requirements by the manufacturers. The responsibility for the purchase, installation, and management of parks' equipment is on the municipalities.

The municipality is obligated to obtain equipment with a standard certificate. Some children's play equipment were purchased in the past (there was no standard for this equipment then). Thus, some of this equipment lack standard certifications. In addition, a number of equipment, which at the time of purchase was certified as standard, have no credit currently, which is because of their expiration. As mentioned above, the safety of industrial jobs is currently being considered, and the concept of urban safety, especially in small towns and parks, has received limited attention from urban managers. Children's incidents have extensive socioeconomic damages. Therefore, evaluating the safety of parks can improve the health and quality of life of visitors and facilitate their access to the parks' equipment. The present study investigated the general safety of equipment in children's playgrounds and their compliance with national standards in public parks.

Methods

This cross-sectional and analytical study was conducted in all parks of Gonabad City, Iran, in the Autumn and Winter of 2017. In this study, all urban parks (7 parks) in Gonabad City with children playgrounds were studied in a census method. We initially explored the status of matching playgrounds with existing standards. Then, the research structure was formed based on this matter. The data collection tool was the 124-item checklist of

Standard Requirements of No 6436-1 of the Institute of Standards and Industrial Research of Iran. The tool was designed according to the above-mentioned standard by a team of researchers. Accordingly, a question was designed for each requirement listed in Standard No. 6436-1.

Given that the questions were replied with yes/no answers, there was no need to score the items. Finally, all inconsistencies (questions that were answered negatively) were listed in the results section. The data collection method was field survey; after evaluating all non-conformities, the deviation degree of collected checklists was determined.

Results

On average, 9.55% of the requirements of the standard 6436-1 were not implemented in the examined parks. Moreover, of the 124 items (requirements) related to general safety, known as standard requirements 6436-1, 89 items were implemented in all parks. Park 2, with 21 non-conformities (16.9%) and park 1 with 19 inconsistencies (15.32%), had the highest rate of non-compliance with the standards. The percentages of non-conformities related to the requirements of the standards 6436-1 in the parks are shown in Figure 1.

Figure 1 shows that parks 1 and 2 have the highest number of non-compliant standards. Of the 124 items examined, 89 were observed in all parks, and 35 items were not observed in even one of the parks. Non-conformities regarding the general safety of children's playgrounds by the requirements of standard 6436-1 in urban parks are presented in Tables 1 and 2.

The achieved results suggested the following matters: the presence of fractures, cracks, damages or deflections of equipment; the existence of rough surfaces with a risk of injury; depreciation of equipment due to the forces caused by the collision of moving parts; the absence of intermediate piers at altitudes <2000 mm when the total height of a row is >2000 mm above the surface of the ground; the absence of a shock absorber in the whole area of collision below all the playground equipment with a free fall height of >600 mm, and equipment causing compulsory movement in the user's body. The lack of proper design for hazardous conditions created containment inconsistencies existing in at least 70% of the examined parks.

We observed rods or stairs of non-rotational ladders with inequality of distance from each other. Moreover, there was an absence of a significant impact absorption surface when the height falls by >1.5 meters. The equipment was designed in a way that hazardous conditions, like wearing clothes, could cause various hazards, such as strangulation. Besides, there were hard parts and sharp edges in the accessible parts of the equipment. The equipment designs failed to ensure that adults can access them to help children. The aforementioned non-conformities in equipment existed i at least 42% of the surveyed parks.

Discontinuous intervals, non-uniform and horizontal structure with the tolerance of ±3º of stairs, inappropriate slope staircase, and fewer than the standard number of stairs (at least 3), suggest the equipment design in which the body is being protected from getting stuck. The existence of points between the movable parts and the fixed part and the movable part can make it possible to bend or cut the presence of uneven welds, the absence of intermediate horizontal bars or bars that children can

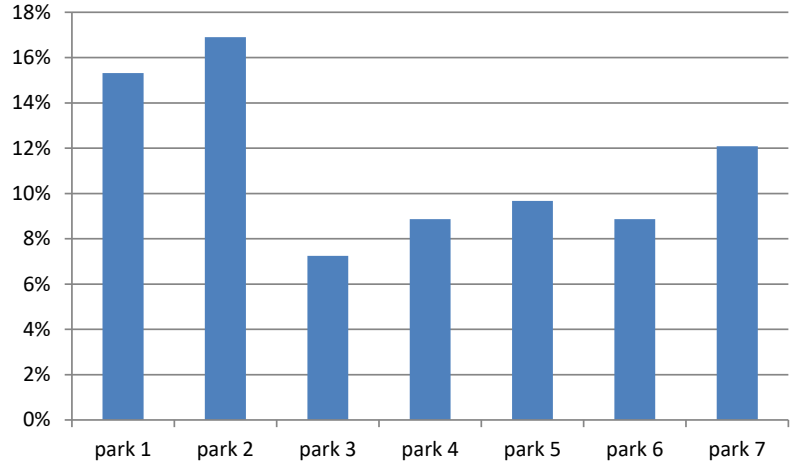

Figure 1. Percentage of non-conformities related to the requirements of standards 1-6436 in the examined parks

Table 1. Non-compliance with the general safety of children's playgrounds in parks1 and 2 according to standard requirements 6436-1

No		Park 1		Park 2
		Yes	No	Yes
1	Does the usage of equipment endanger the children at very high or very low temperatures?	No		No
2	Are the metal parts resistant to various atmospheric conditions?	No		No
3	Do the equipment designs ensure adults' access to them to help their children?	*		No
4	Is the level of impact reduction prepared by the provisions of paragraphs 2-4 of the Iranian National Standard No. 6437?	No		No
5	Is the protection fence prepared for equipment, i.e. not readily available for children <36 months of age when the standing surface is 1000 to 2000 mm above the playground surface?	No		*
6	Is the impact reduction surface available? (If the standing level of equipment is >600 mm above the playing surface).	No		No
7	Are there intermediate horizontal bars or rods that children can raise by their feet?	No		*
8	Are lean surfaces risking harm to children?	No		No
9	Are Outstanding Bolts and nuts in the accessible parts of the equipment permanently coated like round bolts?	No		No
10	Are <8-mm bolts and nuts on the front side not rough?	No		*
11	Are there any hard parts and sharp edges in the equipment?	*		No
12	Do the forces resulting from the collision of the moving parts vanish into each other?	No		No
13	In the openings or space available at the junction of two or more parts, can different parts not get closer to the user's side in <60 mm?	No		No
14	Are there hazardous conditions leading to the capture of children, which are designed by standard 4-2-7-2?	No		No
15	Are the equipment made in a manner that does not create a hazardous condition for wearing clothing that may create a risk of strangulation?	No		No
16	Are the equipment made in a way (by the provisions of the standard) that do not create dangerous conditions in which the foot or leg may be stuck?	No		No
17	Do the running or walking surfaces have an adequate range that prevents the odds of holding the leg or foot?	No		No
18	Have any considerations been taken to prevent unintentional intrusions by users of equipment containing movable seats, including shafts and oscillating tools?	No		No
19	Is the user considered for the level of impact caused by various equipment movements?	*		No
20	Is a fall height of >5 m considered within a fall area with an extra impact level?	No		No
21	Are there any obstacles in the open spaces, such as tree branches, ropes, cross-cams, etc. that children face when using the equipment?	*		No
22	Is there an impact absorption surface in the entire area of attack, underground equipment with a free fall height of >600 mm or equipment causing compulsory movement in the user's body (e.g. rolling, sliding, swinging equipment, rope rails, carriages)?	No		No
23	Are the rods or stairs of the ladder non-rotational and spaced equal to each other?	No		No

* Compliance

Table 2. Non-compliance with the general safety of playgrounds in parks 3 to 7 according to standard requirements 6436-1

No		Park3		Park4		Park5		Park6		Park7
		Yes	No	Yes	No	Yes	No	Yes	No	Yes
1	Is there any fracture, cracking, or alteration in the equipment?		No		No		No		No	No
2	Are the equipment designed to ensure that adults can access them to help their children?		No		*		*		No	*
3	Is the impact reduction surface available? (If the standing level of equipment is >600 mm above the playing surface).		*		No		*		*	*
4	Is the top part of the guard designed in a way to not encourage the children to sit on the guard and not to climb the guard?		No		*		No		No	*
5	Are lean surfaces risking harm to children?		*		No		No		*	No
6	Are outstanding bolts and nuts in the accessible parts of the equipment (i.e. permanently coated like round bolts?)		*		*		No		*	No
7	Are <8-mm bolts and nuts in the front side inadequate?		*		*		No		*	No
8	Are all the welds smooth and uniform?		*		No		*		*	*
9	Are there any hard parts and sharp edges in the available parts of the equipment?		No		*		*		No	*
10	Are there points between movable parts or fixed portions and moving parts that may cause cut or bite in children?		*		*		*		*	No
11	Are the forces resulting from the collision of the moving parts vanished into each other?		No		No		No		No	No
12	Is the equipment made in a way that their hole or open areas cause no head and neck trapping? (When foot first passes or when head passes first).		*		No		No		No	No
13	Are there hazardous conditions leading to the capture of children (designed by standard 4-2-7-2)?		*		*		No		No	No
14	Is the equipment made in a way to not create a hazardous condition for clothing that may create a risk of strangulation?		*		*		*		*	No
15	Are the equipment made in a way (by the provisions of the standard) that create no dangerous conditions in which the body may be stuck?		*		*		No		*	*
16	Do the running or walking surfaces have a range without chances to hold the leg or foot?		*		*		*		*	No
17	Are the ends of the tubes and pipes closed to prevent the risk of finger engagement?		*		No		No		*	*
18	Does the user consider the level of impact caused by the various movements of the equipment?				No		*		*	*
19	Is it considered for a fall height of >5 m within a fall area with an extra impact level?		*		No		*		*	*
20	Are there any obstacles in the open spaces, including tree branches, ropes, cross-cams, etc. that children face them when using the equipment?		*		*		*		No	*
21	Is there an impact absorption surface in the entire area of attack, underground equipment with a free fall height of >600 mm and equipment that causes compulsory movements in the user's body (e.g. rolling, sliding, swinging equipment, rope rails, carriages)?		No		No		No		No	No
22	Are the rods or stairs of the ladder non-rotational and spaced equal to each other?		*		*		*		*	No

No		Park3		Park4		Park5		Park6		Park7
		Yes	No	Yes	No	Yes	No	Yes	No	Yes
23	Is the stair slope constant, and the stairs have at least three steps? Does the open section comply with the provisions of 4.2.2.2.2?	*		*		*		*		No
24	Is the floor of the stairs of the same distances, uniform, and with a horizontal structure with a tolerance of ±3?º	*		*		*		*		No
25	Is there an intermediate pit where needed?	No		No		*		No		*
26	Are the connections so tight that they cannot relax?	No		*		*		No		*
27	Are the connections so protected that they cannot be opened without using tools?	No		*		*		No		*

* Compliance

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step up. The lack of fencing for equipment that is not readily accessible to children <36 months was among the non-conformities that only existed in some parks.

Discussion

Based on the study results, on average, 9.55% of standard requirements were not implemented in investigated parks. Of the 124 requirements contained in the standard protocol, there were 21, 19, and 12 mismatches in the parks 2, 1, and 7. Thus, such a matter should be prioritized by the responsible organizations. There were also 12, 11, 11, and 9 inconsistencies in parks 5, 4, 6, and 3, respectively. The results of various studies have revealed the effect of safety and accidents on human mental disorders. The safety of children's play equipment profoundly influences their biopsychological health and requires adequate attention.

We failed to find a study similar to the present one to compare the results. Thus, this was the first study conducted in this regard. Studies on the standardization of children's playgrounds are scarce. Moreover, most studies have examined the public health and safety status of parks, regardless of standards for children's playgrounds. Additionally, almost all studies in the field of park safety have applied questionnaires and interviewed parents [12-16]. Naeini et al. investigated children's safety in the playgrounds of urban parks in Tehran's local-regional parks; 160 parents of children were interviewed.

Moreover, environmental and equipment safety was investigated through expert observation. They found that in >89% of the examined swing and slides, the industrial structure of the two devices had significant potential for damaging [15]. Additionally, >68% of the park's equipment could cause harm to children. The lack of maintenance of park equipment has caused the risks of moving, running, and walking on installed floors [15]. However, because the method and purpose of the studies are quite different, the study results were not comparable. However, the results of both studies emphasized the importance of safety in parks. Naeini et al. reported that in 78% of the cases, the safety problems worried mothers about playing their children in the parks [15].

Furthermore, Ebrahimzadeh et al. explored the safety status of urban parks in Izeh City. They concluded that none of the 10 studied parks had standard conditions [14]. This finding is consistent with that of the present study. Accordingly, urban managers must pay more attention to this crucial issue and take urgent measures to improve the safety of urban parks. Despite the fact that the playing surface should be sufficiently soft and bulky to prevent injury, 70% of the children's playgrounds have no proper shock absorption. Cement, asphalt, sandstone, grass, soil, and compact soil are inappropriate for preventing childhood injuries.

Additionally, inappropriate land may result in falling among children. This is because falling is very common according to various studies conducted in terms of the game's events [17-20]. According to the obtained results, most of the equipment on the ground had fractures, cracks, or alterations. In >70% of children's playgrounds, rough surfaces were found with a risk of injury. In addition, midgets were lacked and hazardous conditions existed due to inappropriate design; inaccuracies were detected in at least 70% of the examined parks.

Kakayeh et al. explored the health and safety of equipment and children's playground in parks of Ilam City. They suggested that 71.43% of parks had moderate standard status in terms of the health and safety of children's playgrounds. Health and safety indicators for carousel with rotating chair, swing, slides, swing devices, axial flip-flop, and indicators of public criteria of children's

playground were moderate in 100%, 85.7%, 66.7%, 66.7%, 60%, and 57.1% of the cases, respectively [21]. Therefore, it is necessary for city managers, including small-town managers, to consider the safety dimensions of national standards in designing children's playgrounds. In our country, urban design has no long history, and the design of children's play spaces, especially in the age group of 5 to 12 years, has a lower priority [22].

Numerous research studies have been conducted in European and American societies; various solutions have been proposed to promote urban spaces for children and design a new generation of playgrounds. However, in eastern societies, especially in our country, there is no comprehensive research focusing on children's playgrounds, especially in the age group of 5 to 12 years. Considering the experiences of Western societies, measures are being taken in the framework of modernization and improvement projects [22]. Accordingly, it is also proposed to provide anthropometric data for the design and construction of ergonomic equipment. Such data could be supplied to the manufacturers of park equipment in the country while implementing integrated safety, health, and environment management.

It is also suggested that relevant organizations and institutions provide dimensional and anthropometric standards as well as preliminary data. These materials are essential in designing children's safe play equipment by proper interaction with the research centers and the Institute of Standards and Industrial Research of Iran. The current study had some limitations. Because this was a cross-sectional study and due to the socio-economic and cultural conditions governing small towns rather than metropolitan areas, it was impossible to generalize the obtained results to the whole country. However, this study, compared with other studies, has significant advantages, as follows: First, for the first time, we examined the general status of children's playground safety by national standards. Second, the collected results could be used for small city managers. Third, this study, unlike other studies on the safety of parks, which address general safety issues, was an applied investigation. Moreover, all nonconformities were explored in this study, which could be highly applicable to executive and urban executives.

Conclusion

The present study indicated that there are various inconsistencies in all studied parks, and none of the parks were fully compatible with the national standards. The standardization of children's play equipment in terms of safety and health in public parks, including small towns, is undeniably indispensable. The obtained results highlighted the necessity for the safety of children's play equipment. Designing slides as well as modifying the playgrounds of children's play equipment according to the relevant standards are among the top priorities.

Ethical Considerations

Compliance with ethical guidelines

This research was approved by the Ethics Committee of Gonabad University of Medical Sciences, Iran (Ethics Code No. IR.GMU.REC.1396.79).

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Authors' contributions

Study design: Mohammad hosein beheshti, Ali Alami, Maryam Borhani Jebeli; Data collection and analysis: Ehsan hamamizadeh, Ali Tajpoor, Farahnaz Khajenasiri; Manuscript preparation: Mohammad Hosein Beheshti, Seyyed Ehsan Samaei, Farahnaz Khajenasiri, Ahmad Mehri.

Conflict of interest

The authors declared no conflicts of interest.

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