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SAFE PLAYGROUNDS: AN ANALYSIS IN THE CONTEXT OF REGULATIONS AND SELECTED DESIGN PRINCIPLES

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ABSTRACT

Playgrounds are intended to provide children with safe and welcoming spaces for recreation. In many countries, including Poland, safety requirements are governed by specific standards and regulations. Unfortunately, these regulations are not always observed, which undermines the function of playgrounds as secure environments for play. This study, conducted in Wrocław on a residential estate dating from the 1970s–1980s, aimed to assess whether the design and infrastructure of playgrounds comply with legal safety requirements and incorporate appropriately planned greenery. The analysis considered, among other factors, the distance of playgrounds from streets, parking lots, and waste collection points; the presence of fencing; certified equipment with designated safety zones; the type of shock-absorbing surfaces; access to sunlight and shade; as well as biologically active areas and plant species composition. The findings reveal that the examined playgrounds largely fail to meet applicable standards and regulations: 100% of sites were equipped with unsuitable loose surfaces, 80% displayed inadequately designated safety zones around equipment, and play areas consistently lacked shade. The results highlight the gap between current knowledge, legal requirements, and the actual safety and comfort of playground use. They also provide practical insights for managers and designers seeking to improve the quality and safety of playground environments.

Keywords: children's recreation, safe playgrounds, child friendly city

INTRODUCTION

A substantial body of research on child well-being and development demonstrates that early-life experiences exert a profound influence on later success and the quality of adult life. This impact encompasses a wide range of dimensions, including emotional health, cognitive capacities, socioeconomic status, and overall well-being (Dovie, 2024; Flèche et al., 2021; Hertzman & Wiens, 1996). Article 31 of the United Nations Convention on the Rights of the Child explicitly states that every child has the right to rest and play. In this framework, play is not a mere supplement to daily life but a vital component of physical, social, and cognitive development, providing both health benefits and joy (United Nations). The World Health Organization recommends that children engage in at least one hour of moderate-to-vigorous physical activity daily (WHO, 2010). Yet, evidence shows that the majority of children fail to meet this target

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(Aubert et al., 2022), with detrimental consequences for their health (WHO, 2017). Growing urbanization has further restricted children's freedom of movement. Contemporary generations – often described as the "indoor children generation" – spend much of their time indoors, with recreational activities increasingly taking place in shopping centers or enclosed playgrounds (Newson & Newson, 2017). Children also devote significant portions of their day to tablets and mobile phones, which shape and mediate their understanding of the surrounding world (UNICEF Tanzania, 2012). Such sedentary lifestyles, combined with poor dietary habits, contribute to chronic diseases and health disparities. These issues are exacerbated by children's limited ability to choose or alter their environments (Audrey & Batista-Ferrer, 2015).

Findings from the Millennium Cohort Study in the United Kingdom indicate that independent outdoor play strongly promotes moderate-to-vigorous physical activity (Aggio et al., 2017). Extending the time children spend outdoors not only fosters free, spontaneous, and creative play but also reduces reliance on adult-organized or supervised activities (Lee et al., 2021). Playgrounds, in particular, serve as critical environments for enabling such experiences. Properly designed playgrounds support holistic development, enhancing both motor and social skills (Butler, 2016; Moore et al., 2020; Pawlowski et al., 2023; Sluckin, 2017; Wellhousen, 2002). They facilitate the acquisition of fundamental movement skills and physical coordination (Quigg et al., 2012; Pulatkan & Güneroğlu, 2023), foster social integration among peers (Bennet et al., 2012; Bundy et al., 2009; Schipperijn et al., 2024), and can strengthen children's sense of belonging and social inclusion (Jespersen, 2024; Tait et al., 2024).

Moreover, playgrounds yield significant mental health benefits, particularly those incorporating natural greenery into their design (Schipperijn et al., 2024). They are generally perceived as safe environments, where children spend more time than in most other recreational settings (Dodd et al., 2020). For this reason, playground design must carefully balance interest and safety. The primary determinants of safety include certified and well-maintained equipment appropriate for the age group, shock-absorbing surfaces for fall protection, adequate distance from streets, and, in some contexts, fencing (Arroyo-Johnson et al., 2016; Sansakorn et al., 2022; Unal & Cevik, 2025). Researchers also emphasize the importance of combining shaded areas providing protection from excessive UV radiation with sunlit zones, as moderate sunlight exposure is essential for vitamin D synthesis, whose deficiency has well-documented negative health outcomes (Cheng et al., 2025). Additionally, the integration of vegetation into playground design enhances environmental quality and improves users' thermal comfort (Vanos, 2015).

Design flaws and insufficient maintenance of playgrounds can significantly reduce safety and increase the risk of accidents. In the United States alone, more than 200,000 children are treated annually in emergency departments for injuries resulting from falls on playground equipment (Suminski et al., 2015). Over half of these incidents involve falls from climbing frames, most commonly leading to upper limb injuries (ibid.). Similarly, in New South Wales, Australia, 7795 child hospitalizations were recorded over a 4.5-year period due to playground-related falls. The majority of these injuries were caused by falls from trampolines (34.3%) and climbing structures (28.2%), with more than half resulting in arm fractures, particularly of the elbow or wrist (Bierbaum et al., 2018). Hospitalization rates for playground-related injuries remain high in both countries. Researchers consistently stress the need for stricter regulations, particularly regarding the properties of shock-absorbing surfaces, as a means of enhancing safety during play (Adelson et al., 2018; Bierbaum et al., 2018). Many countries, including those in the European Union, have enacted regulations governing the design and maintenance of playgrounds.

In Poland, two standards aligned with European regulations are in force: PN-EN 1176, which specifies safety requirements for playground equipment and surfaces, and PN-EN 1177, which applies exclusively to impact-attenuating surfaces. In addition, playground design and inspection are regulated by the Building Law (Journal of Laws of 1994, No. 89, item 414,

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as amended) and by the Regulation of the Minister of Infrastructure on the technical conditions that buildings and their location must meet (Journal of Laws of 2002, No. 75, item 690, as amended). These provisions address, among other aspects, the minimum distance of playgrounds from potential hazards, the required proportion of biologically active surface within playgrounds, and minimum standards for sunlight exposure. On 1 August 2024, an amendment to Polish playground regulations came into force (Journal of Laws of 2023, item 2442). The new provisions are intended to raise safety standards and improve the quality of children's recreational spaces. They include, for example, requirements concerning the minimum area of playgrounds depending on the number of nearby residents, as well as the obligation to fence children's play areas to enhance their safety.

Against this backdrop, the aim of the present study was to evaluate the spatial design of Polish playgrounds in relation to current regulations and principles ensuring both safety and user comfort.

MATERIALS AND METHODS

Study Area

The study was conducted in the Nowy Dwór housing estate in Wrocław, Poland, which covers an area of 231 hectares. Residential zones account for the largest share of land use (41%), while green spaces constitute 8.4% of the total area. The dominant form of development consists of multi-family block housing, constructed in the 1970s and 1980s using prefabricated large-panel technology. In addition, parts of the estate include single-family houses dating back to the interwar period, later expanded and supplemented in the post-war decades. A detailed distribution of land-use functions within the estate is shown in Fig. 1.

Study Procedure

The research adopted a descriptive, cross-sectional design and was carried out in successive stages during the second quarter of 2024. Data collection was based on site visits, direct observation, and field measurements. Measurements were conducted using a measuring tape and a laser distance meter, supported by a cadastral base map obtained from the Wrocław Municipal Surveying, Cartography, and Land Registry Authority. The primary objective of the study was to examine the spatial organization of playgrounds and to address the following research questions:

What types of playgrounds exist within the estate, who manages them, are they publicly accessible, for which age groups are they intended, and are they adapted to the needs of children with physical disabilities?

To what extent do the playgrounds of the study area comply with Polish safety standards and regulations?

Do other spatial elements – those not explicitly regulated by law – affect playground safety?

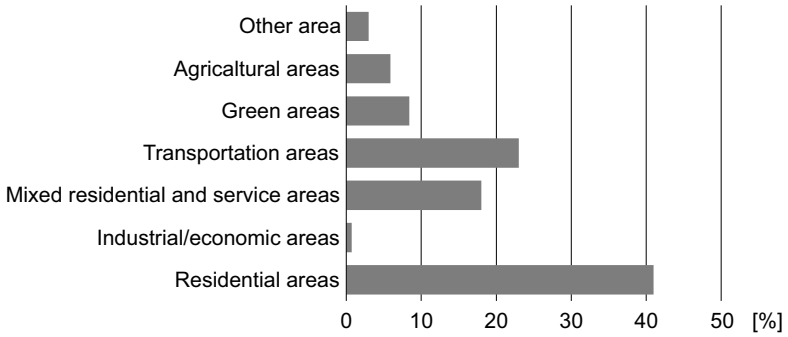

Fig. 1. Land-use distribution within the Nowy Dwór housing estate
Source: own elaboration based on data from the Wrocław Spatial Development Conditions and Directions Study, 2018 (SUiKZP, 2018).

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Is greenery present within the playgrounds, and if so, is it safe for children (i.e., free from poisonous species, thorns, or spines)?

Does the vegetation or other design elements provide adequate shade for play equipment and rest areas?

The study was conducted in three successive stages.

In the first stage, all playgrounds within the housing estate were identified, their managing entities determined, and they were categorized into two groups: playgrounds located within educational facilities (with and without public access) and those situated in publicly accessible areas.

In the second stage, 29 playgrounds out of the 32 identified were selected for detailed investigation. One playground was excluded because it was under reconstruction, while access was not granted to two playgrounds located on school premises. At the selected sites, field inspections were carried out and photographic documentation was prepared. Based on spatial arrangement, information from regulations, and labels attached to specific pieces of equipment, the playgrounds were classified into four categories: those for very young children under 3 years (early childhood), for children aged 3–6 (preschool-aged), 7–11 years (early school age), and 12 years and above (adolescence). The degree of adaptation for children with reduced mobility (including wheelchair users and those with chronic conditions) was also assessed, as well as the suitability of the playgrounds for adult presence and recreation.

In the third stage, compliance with Polish legal regulations ensuring playground safety was analyzed and evaluated. The assessment included: the distance from streets, waste collection points, and parking lots; the presence of fencing; surface type; the quantity, type, materials, and condition of play equipment; designated safety zones; shock-absorbing surfaces; biologically active areas and the character of vegetation; as well as levels of sunlight exposure and shade within the playgrounds.

The methodological framework of the study is illustrated in Fig. 2.

The summary of the analyzed playground elements, with reference to the applicable regulations in Poland and the guidelines contained therein, is presented in Table 1.

Current regulations clearly define the required distance between playgrounds and potentially hazardous or disruptive sites such as streets, parking areas, and waste collection points (Journal of Laws of 2023, item 2442). Compliance with these provisions reduces children's exposure to traffic-related accidents and to unpleasant odors emanating from waste storage areas. The regulations also establish specific requirements for fencing. According to the Regulation of the Minister of Development and Technology of 20 October 2023 amending the Regulation on the technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442), playgrounds adjacent to roads, streets, parking areas, or shared pedestrian–vehicular paths must be enclosed with a fence (§ 40.5). The materials used for such fencing must not pose health risks to playground users. Furthermore, the minimum height of the fence is set at one meter, and it must include a gate at least 1.2 meters wide to ensure accessibility for persons with special needs (§ 40.6.1–2). In other locations, hedges may serve as a natural alternative to conventional fencing (§ 40.7).

Another critical dimension of child safety concerns so-called "safety zones." These zones encompass the areas beneath and surrounding play equipment, which must remain free from obstacles (including other structures), thereby preventing collisions in the event of a fall. The size of each safety zone is determined by the potential fall height, corresponding to the maximum level at which children may engage in play (PN-EN 1176).

Equally vital is the playground surface, which is designed to protect children from injuries caused by falls. Its primary function is to absorb impact, thereby reducing the likelihood of serious harm (PN-EN 1176-1). Different surface types are recommended depending on the potential fall height. For equipment up to one meter in height, grass or natural soil is sufficient. For higher equipment,

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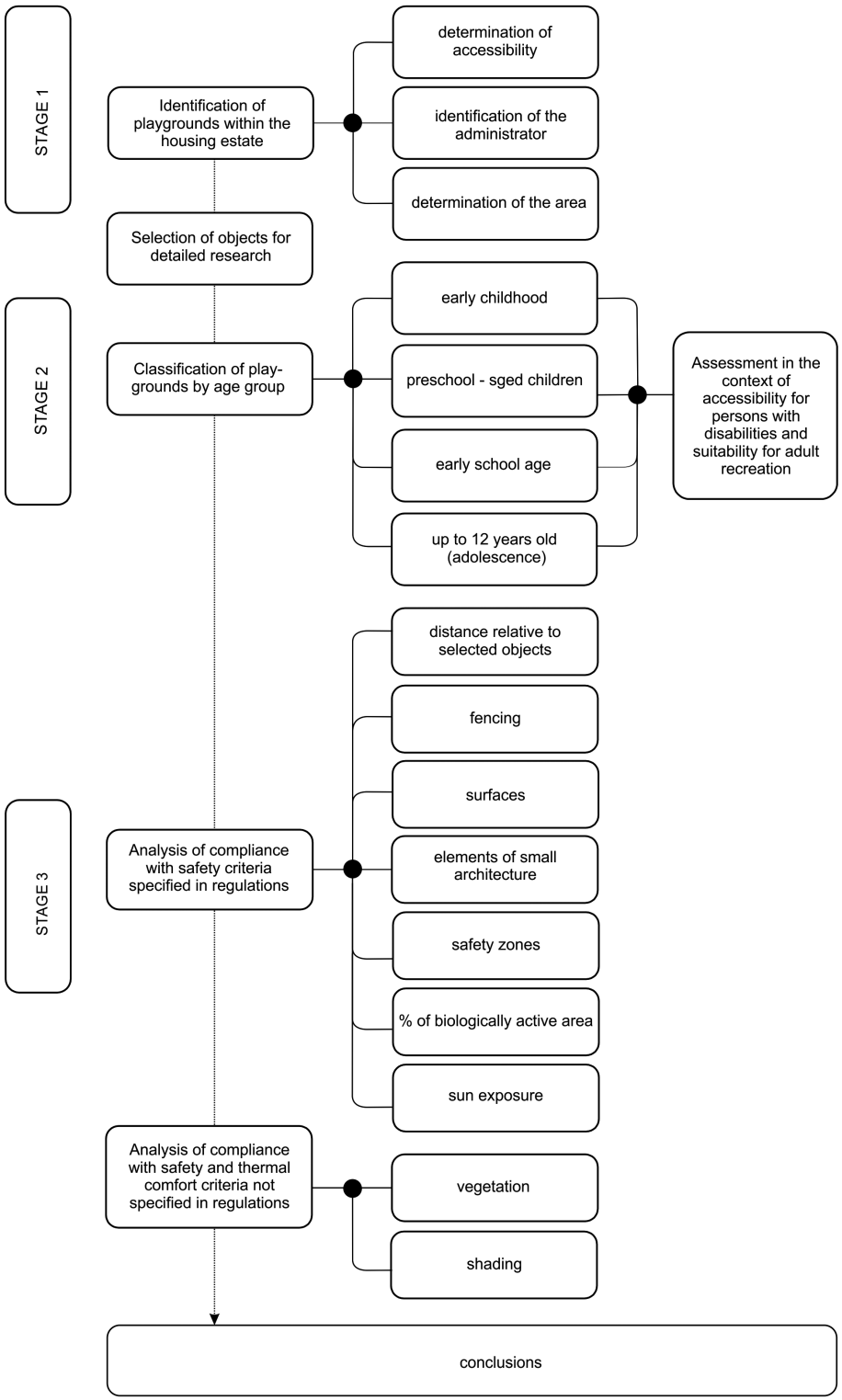

Fig. 2. Methodological framework
Source: own elaboration.

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Table 1. Summary of the analyzed playground elements with reference to the applicable Polish regulations and the guidelines contained therein

No.	Examined Element	Name of Standard or Legal Act	Guidelines Contained in Standards or Legal Acts
1	2	3	4
1	Distance from streets, waste collection points, parking areas	1. § 40 of the Regulation of the Minister of Development and Technology of 27 October 2023 amending the regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442)	Re. 1 Playgrounds should be located 10 m from street boundaries, roads, pedestrian-vehicle paths, and waste collection sites
		2. § 19 of the Regulation of the Minister of Infrastructure of 12 April 2002 on technical conditions to be met by buildings and their location (Journal of Laws of 2002, No. 75, item 690, as amended)	Re. 2 Distance from parking depends on the number of designated parking spaces: up to 4 spaces – 7 m, 5–60 spaces – 10 m, more than 60 spaces – 20 m
2	Fencing	1. Regulation of 31 December 2002 on safety and hygiene in schools and public and non-public institutions	Re. 1 School and institutional Premises should be fenced
		2. Regulation of the Minister of Development and Technology of 20 October 2023 amending the regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442)	Re. 2 Playgrounds for children should be enclosed. Fencing should have: a minimum height of 1.0 m, a gate AT least 1.2 m wide allowing access for persons with special needs, in specific situations, a hedge may be used as fencing
3	Safety zones	PN-EN 1176	The size of the safety zone depends on the height of potential fall, i.e., the height at which children can play. For equipment with a fall height up to 150 cm, the safety zone should be 150 cm. Exceptions apply to movable equipment
4	Surfaces	PN-EN 1177+AC:2019-04	To ensure user safety in the safety zone, appropriate impact-absorbing surfaces must be provided. The surface must cover the entire fall area under Any equipment with a free fall height above 60 cm. The standard specifies types of safe surfaces and thickness requirements for loose-fill surfaces
5	Small architectural objects: benches, waste bins	-	No regulations in legal acts
6	Playground equipment	1. PN-EN 1176	Re. 1 Detailed information on playground equipment, e.g., swings, slides, rope tracks, carousels
		2. § 40 of the Regulation of the Minister of Development and Technology of 27 October 2023 amending the regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442)	Re. 2 Playground equipment and surfaces must comply with Polish Standards regarding playground equipment and surfacing

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cont. Table 1

1	2	3	4
7	Biologically active area	§ 40 of the Regulation of the Minister of Development and Technology of 27 October 2023 amending the regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442)	At least 30%
8	Selection of plant species	-	No regulations in legal acts
9	Sun exposure	§ 40 of the Regulation of the Minister of Development and Technology of 27 October 2023 amending the regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2023, item 2442)	At least 50% of the playground area should receive sunlight for at least 2 hours on equinox days, between 10:00–16:00. In Urban areas, a minimum of 1 hour is acceptable
10	Shading	-	No regulations in legal acts

Source: own elaboration based on Journal of Laws of 2023, item 2442, Journal of Laws of 2002, No. 75, item 690, as amended, PN-EN 1176, PN-EN 1177+AC:2019-04.

certified "safety surfaces" are required, which may consist of loose-fill materials – such as bark, wood chips, sand, or gravel – of at least 30 cm thickness (for a maximum fall height of 2 meters) or 40 cm thickness (for a maximum fall height of 3 meters). Alternatively, synthetic safety surfaces may be used. In any case, the maximum permissible free fall height from equipment is limited to 3 meters (PN-EN 1177).

Playground equipment itself, to be legally approved for use, must comply with national standards (Journal of Laws of 2023, item 2442) and obtain certification from accredited institutions that verify compliance with established safety requirements.

Complementary, yet significant, elements of playgrounds include small-scale infrastructure such as benches and waste bins. Beyond their functional and aesthetic contributions, these features must also be safe, with no sharp or hazardous edges that could endanger children. Benches should be placed so as to afford caregivers a clear view of as much of the playground as possible. They should also be set back at least one meter from fences, thereby preventing their misuse for climbing or jumping over enclosures (Yearley & Berliński, 2022). Waste bins, in turn, should be installed two to three meters from benches and entrances to discourage their use as play objects and to reduce the risk of insect-related hazards. Both surfaces and small architectural elements were evaluated using a five-point scale, where 1 denoted very poor condition and 5 indicated the highest quality. The evaluation criteria included the presence of hazardous features and inappropriate placement.

Vegetation constitutes another essential element, valued not only for its ecological and microclimatic functions (Klimowicz, 2020) but also for its positive influence on children's physical and psychological development (Schipperijn et al., 2024). When selecting plant species for playgrounds, safety must be prioritized: species with thorns, spines, sharp edges, or toxic components should be strictly avoided (Kosmala, 2014). Properly chosen vegetation can also stimulate imaginative play, enabling children to engage with natural materials such as sticks, leaves, or fruits (ibid.). Such opportunities foster direct interaction with nature and support species recognition skills. While current regulations do not specify plant selection criteria, they do mandate that biologically active green space must account for at least 30% of the playground's total area (Journal of Laws of 2023, item 2442).

Finally, children's health and safety are strongly influenced by sunlight and shade on playgrounds. According to existing legal provisions (Journal of Laws of 2023, item 2442), playgrounds must receive at least two hours of direct sunlight per day – or at least one hour in dense urban areas – measured during the equinox between 10:00 and 16:00. Sunlight is

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particularly important in areas such as sandpits, where solar exposure naturally reduces bacterial presence. Conversely, adequate shading, provided by vegetation or architectural structures, is crucial for thermal comfort and protection from ultraviolet radiation (Cheng et al., 2025; Cherian & Subasinghe, 2023; Corcoran et al., 2023).

RESULTS

The primary administrator of children's playgrounds in the Nowy Dwór housing estate is the *Nowy Dwór Housing Cooperative*, which manages 65.5% of all playground facilities. Educational institutions are responsible for 15.6% of the analyzed sites, while the Municipal Greenery Authority oversees a further 6.3%. For four playgrounds, however, the administrator could not be identified (Fig. 3).

The surface areas of the analyzed playgrounds vary considerably. The largest facility is Playground No. 28, located at Primary School No. 113 on Zemska Street. In contrast, the smallest is Playground No. 14, covering only 150 m^2; it is situated within a green space on Rogowska Street and managed by the Municipal Greenery Authority. More than half of the playgrounds occupy an area of up to 500 m^2.

Of the 29 playgrounds analyzed, 27 are designed for preschool-aged children (3–6 years). Facilities for younger children, under the age of 3, are available at 24 playgrounds, while 23 sites are adapted for children between 7 and 11 years of age. Only 10 playgrounds are intended for children over 12 years old (Fig. 4).

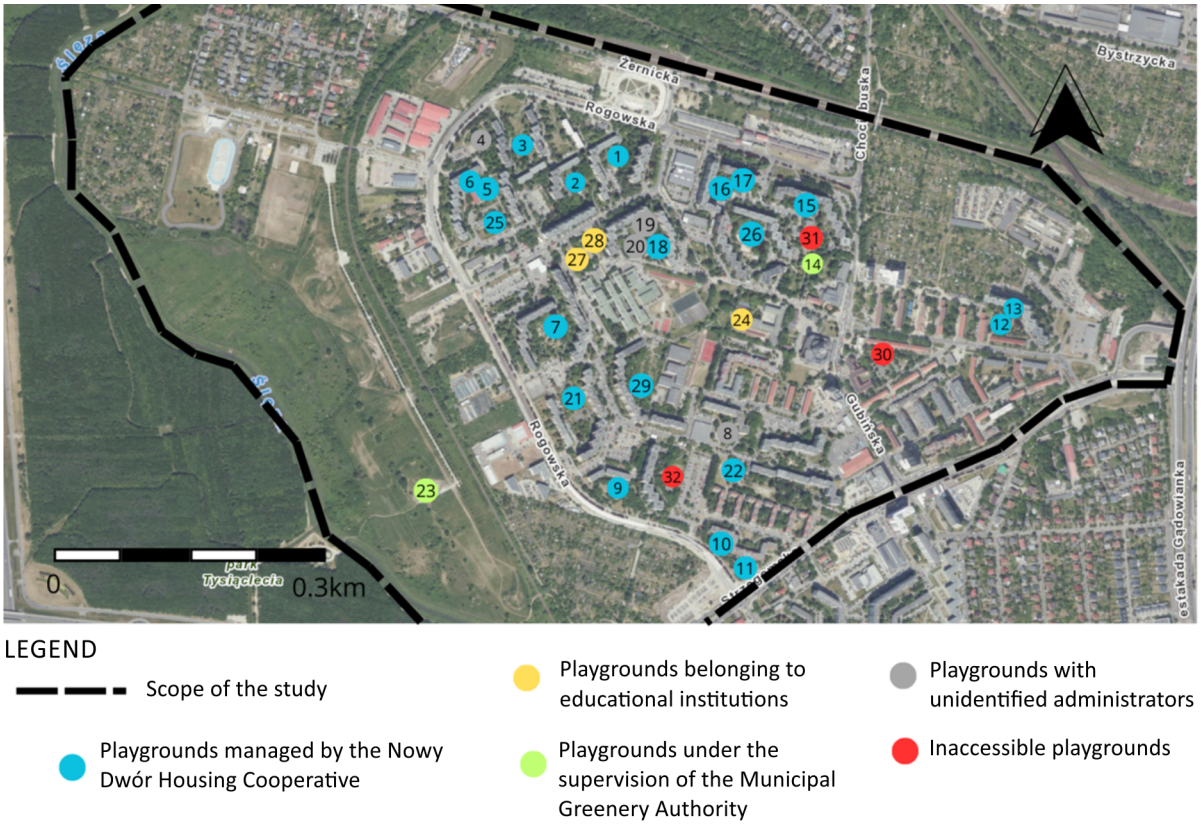

Fig. 3. Distribution of playgrounds within the Nowy Dwór housing estate, with an overview of their respective administrators

Source: own elaboration.

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Unfortunately, none of the playgrounds provide facilities specifically dedicated to children with special needs. One playground includes a ramp for wheelchair users; however, the site itself lacks play equipment adapted for children with mobility impairments.

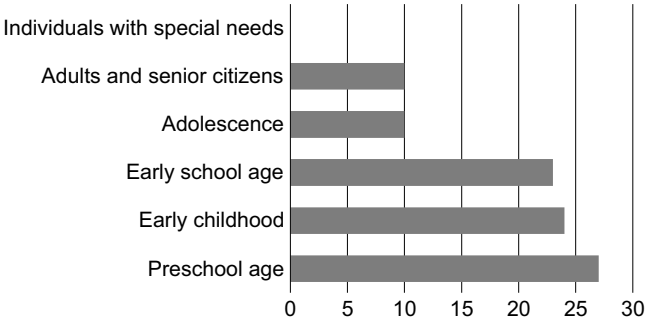

Fig. 4. Age groups for which the playgrounds in the Nowy Dwór housing estate are designated
Source: own elaboration.

The examination of safety-related elements, as required by Polish law, revealed numerous irregularities.

Distances from buildings, streets, roads, mixed pedestrian–vehicular routes, waste containers, and parking areas

At three playgrounds, the required distance from buildings and waste collection points was not maintained. At two playgrounds, insufficient distance from the street was observed. Furthermore, 13 facilities (44.7%) are located in excessively close proximity to parking areas (Fig. 5).

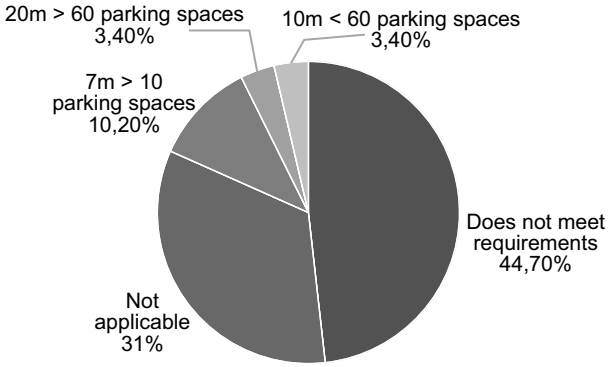

Fig. 5. Distance from parking areas
Source: own elaboration.

Fencing

As many as 81.5% of the analyzed playgrounds are equipped with fencing (Fig. 6a). In all cases, this consists of metal fencing without sharp elements; additionally, in three instances, hedges were used in combination with the fence. In some cases, only a portion of the playground is fenced, which applies to nearly 22% of sites (Fig. 6b). A gate is present in 53.6% of playgrounds; however, 11 facilities fail to meet the legally required gate width, and protective grilles preventing animal entry are installed at only 14% of the sites.

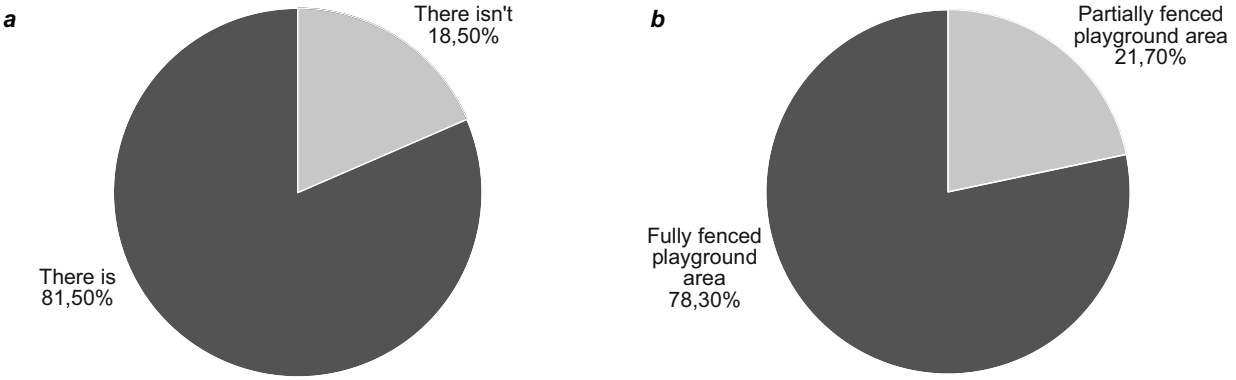

Fig. 6. Fencing: a) presence of fencing at playgrounds; b) extent of fencing – covering the entire playground or only a portion
Source: own elaboration.

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Securing safety zones

Studies on safety zones have shown that in more than 80% of playgrounds these zones are inadequate (Fig. 7).

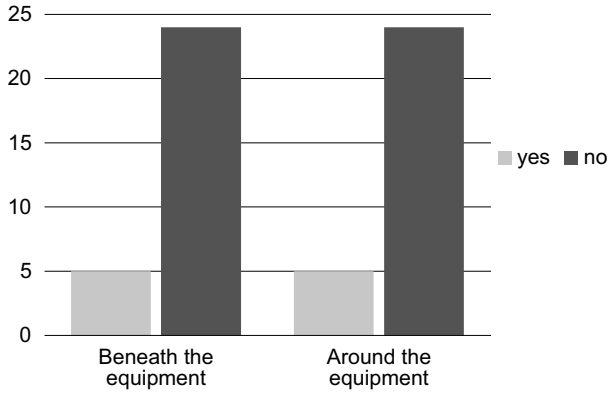

Fig. 7. Presence of safety zones beneath and around playground equipment
Source: own elaboration.

Playground Surfaces

The surveyed playgrounds were assessed in terms of the type of surface used (Fig. 8), the condition and maintenance of those surfaces, and, in the case of grassed areas, the health of the vegetation (Fig. 9). For loose-fill surfaces, thickness was also measured (Fig. 10). The analyses revealed that grass is the predominant surface type. Its overall condition was rated as moderate, primarily due to worn patches and uneven tufts of grass, both of which may increase the risk of tripping. The second most common category of impact-absorbing surface consists of loose materials such as sand and gravel which together account for 34% of all safety surfaces identified. However, their technical state was also judged as moderate, as their thickness did not exceed 13 cm, less than half of the required standard. In terms of technical quality, the surfaces received 3 out of a maximum of 5 points, corresponding to an overall "moderate" rating. Notably, none of the loose-fill surfaces met current safety requirements, meaning they would fail to provide adequate cushioning in the event of a fall from playground equipment.

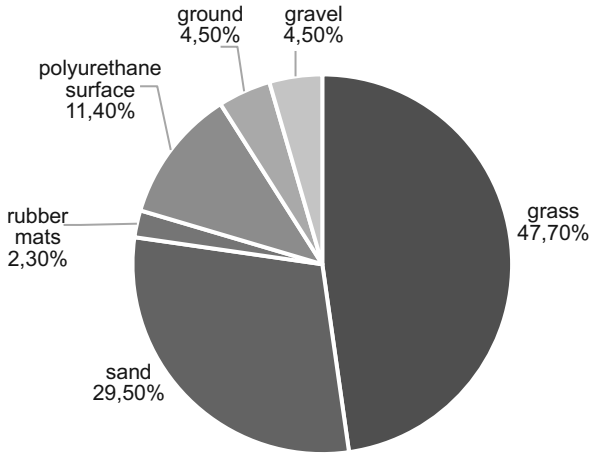

Fig. 8. Classification of surfacing types identified in the surveyed playgrounds
Source: own elaboration.

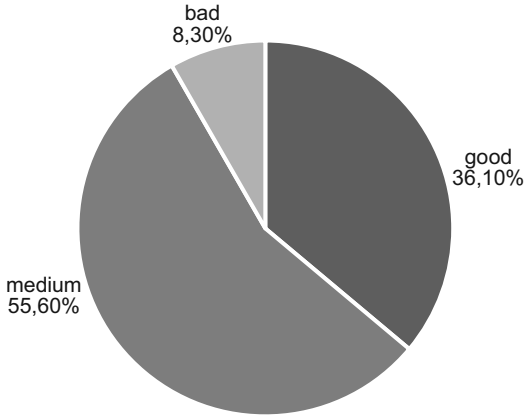

Fig. 9. Technical condition of surfacing materials in the surveyed playgrounds
Source: own elaboration.

Playground Equipment and Accompanying Small Architecture

Within the surveyed areas, small-scale infrastructure such as benches and waste bins was inventoried, and their technical condition was assessed (Fig. 11). On three playgrounds, these elements were found to require repair or replacement due to broken components. On 13 playgrounds, their condition was rated as moderate, mainly because of peeling paint or graffiti. Playground equipment was also inventoried with regard to technical condition (Fig. 12) and the presence

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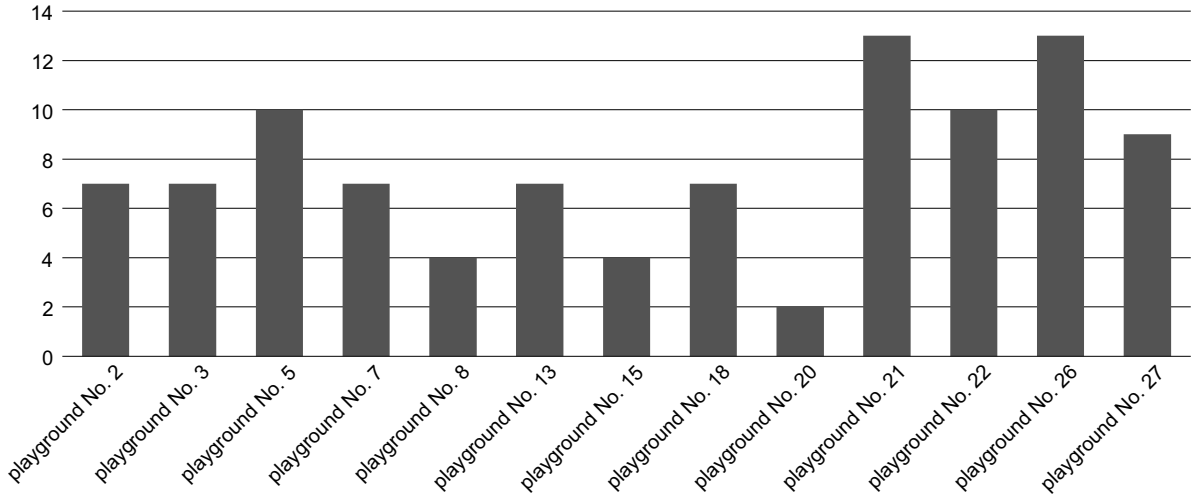

Fig. 10. Thickness of loose-fill surfacing in the surveyed playgrounds
Source: own elaboration.

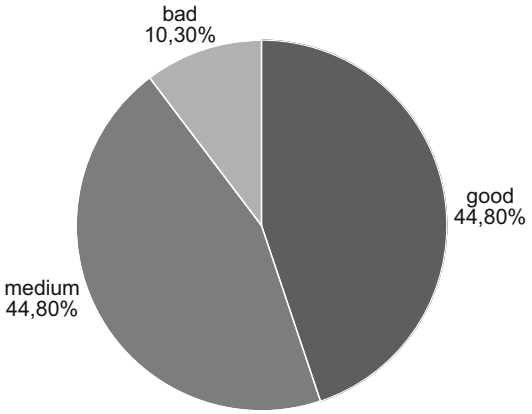

Fig. 11. Technical condition of small architectural elements
Source: own elaboration.

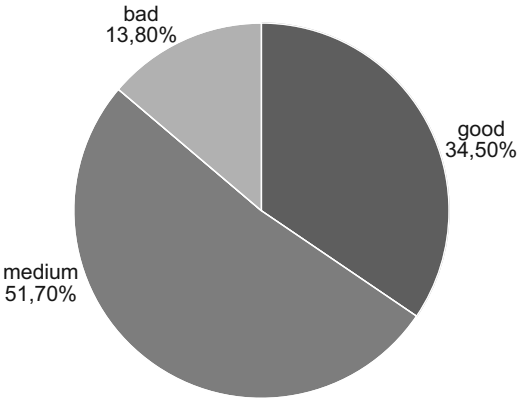

Fig. 12. Technical condition of playground equipment
Source: own elaboration.

of hazardous elements, such as damaged fastenings. The observations revealed that equipment on four playgrounds required repair, while on 15 playgrounds it was classified as being in moderate condition (3 points). On 10 playgrounds, the equipment was rated as good (4 points).

Fig. 13 illustrates the number of playgrounds where hazardous elements were identified on play equipment. The data show that such elements were present on 20.7% of playgrounds. Examples included detached safety straps on bucket swings designed for the youngest children, which are intended to prevent

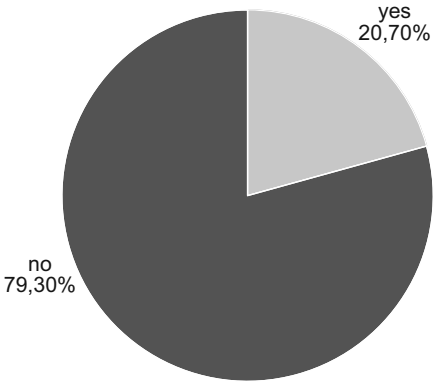

Fig. 13. Presence of hazardous elements in playground equipment
Source: own elaboration.

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slipping, as well as loose boards on the rotating device known as the "Barrel." These defects increase the risk of tripping and may ultimately lead to accidents during play. An additional factor relevant to safety is the material from which the equipment is made. Among the surveyed playgrounds, 85% featured metal constructions, with smaller shares of wood, EPDM rubber, or plastics. These materials differ in how they absorb and retain heat when exposed to sunlight, which in turn affects their safety and usability for children. The presence of playground regulations was also verified. Such regulations are an essential element of playground infrastructure, as they help ensure the safety of children. They should specify permitted and prohibited activities, provide the contact details of the site manager to whom any damage should be reported, and include an address or GPS coordinates to allow emergency services to quickly locate the site in case of an accident. However, not all playgrounds displayed such information: 17% of the surveyed sites lacked a posted set of regulations.

Vegetation and the Share of Biologically Active Areas

The majority of the analyzed playgrounds are surrounded by greenery. This is largely due to their "green" contexts, such as adjacency to parks and

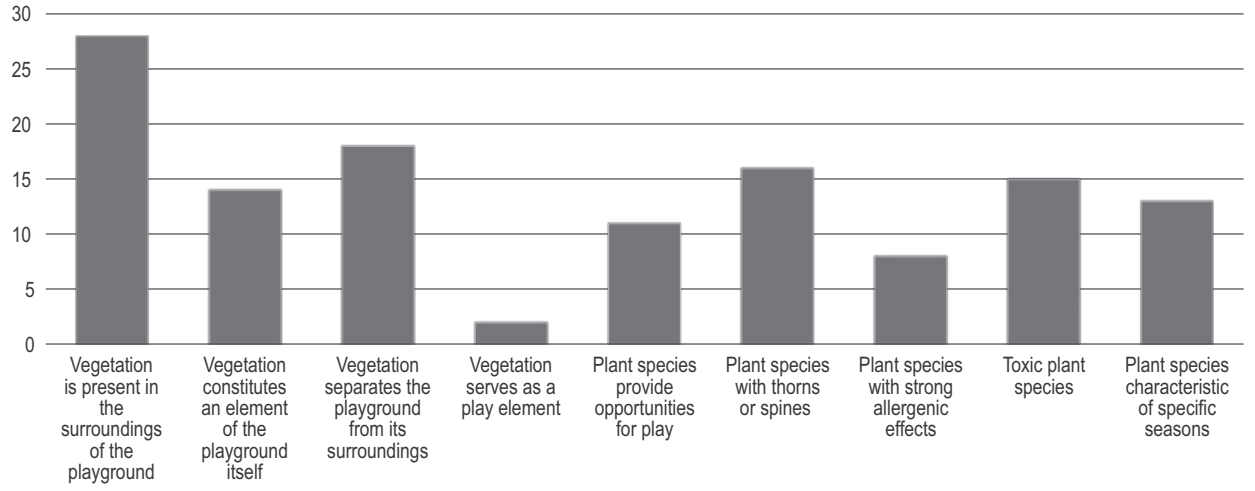

Fig. 14. Characteristics of vegetation on and around the playgrounds
Source: own elaboration.

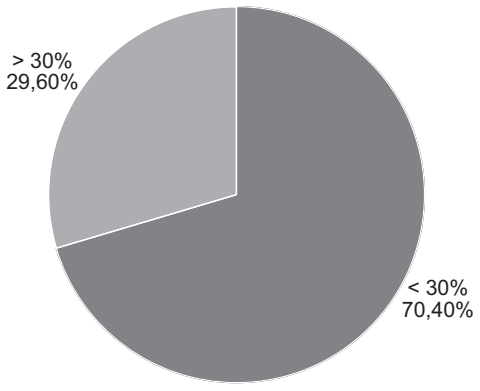

Fig. 15. Percentage of biologically active area in the surveyed playgrounds
Source: own elaboration.

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squares (7% of sites) or the landscaped interiors of housing estates (nearly 80% of sites). Vegetation formed part of the playground equipment on 14 sites, although on only 2 sites did it function directly as a play element. Nearly half of the playgrounds featured vegetation with year-round visual appeal. At 18 sites, greenery also served as a buffer, isolating the play area from its surroundings. When assessing vegetation in terms of safety, both harmful and hazardous species were identified. Toxic plants were present on 15 playgrounds, spiny or thorny plants on 16, and highly allergenic species on approximately one-third of the sites. The most frequently recorded species was *Ligustrum vulgare* (common privet), observed on 14 playgrounds. This shrub bears fruits that are poisonous to humans and is therefore considered undesirable in areas designated for children. The overall results of the vegetation analysis are presented in Fig. 14.

The study also assessed the share of biologically active surface area, which, according to regulations, should constitute no less than 30% of the playground's total area. Nearly one-third of the surveyed playgrounds were found to have a biologically active surface area below this required threshold (Fig. 15).

Sunlight Exposure and Shading of Playgrounds

The analyses confirmed that all playgrounds receive sunlight during the hours specified by regulations. A clear majority (82%) also provide shaded areas, typically located along the perimeters. These shaded zones offer children and their caregivers relief and rest during hot days. However, shading is absent within the central parts of the playgrounds, where most play equipment is concentrated. This lack of coverage may result in the overheating of both the equipment and the surfaces, potentially reducing comfort and increasing safety risks.

DISCUSSION

The assessment of playgrounds in the Nowy Dwór district of Wrocław revealed both positive and negative aspects regarding their spatial organization. The observed deficiencies and safety limitations are primarily associated with non-compliance with legal regulations. This issue has been highlighted in numerous studies. For example, research conducted by Uskun et al. (2008) demonstrated that many playgrounds fail to meet multiple safety criteria. Their study found that 80.7% of playgrounds had inappropriate or hard surfacing, and 52% of playground equipment was deemed unsuitable, often exceeding recommended height limits. Similarly, Botsoglou et al. (2011) reported that nearly all playgrounds in Greece failed to comply with current safety specifications. Comparable findings were observed in Turkey, where playgrounds in central Elazig did not meet established safety standards (Açik et al., 2004).

Within the Nowy Dwór playgrounds, the most significant safety issue was the absence of adequately designated safety zones beneath and around play equipment. Loose-fill safety surfaces also presented considerable problems. Although the materials were appropriate, the depth of loose-fill surfaces was substantially below the required level (13 cm versus the mandated 30 cm). Australian researchers Sherker and Ozanne-Smith (2004) reported similar concerns: while 98% of playgrounds had the recommended surfacing materials, only 4.7% achieved the recommended depth. This discrepancy contributed to numerous accidents, including children sustaining fractured arms from falls.

Another critical factor influencing user safety is thermal comfort. The studied playgrounds lacked vegetation and shading elements in central play areas, which can lead to overheating of equipment and, consequently, increase the risk of burns. Surface material also affects thermal comfort: natural surfaces tend to moderate temperature better than artificial ones, which can become dangerously hot. Olsen (Olsen et al., 2019) demonstrated that natural surfacing materials maintained moderate surface temperatures

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relative to ambient conditions, whereas artificial surfaces often exceeded ambient temperatures. This is particularly relevant given that over 75% of the studied playgrounds lacked shading during peak sunlight hours (10:00–14:00). Elevated temperatures and insufficient shade can adversely affect children's thermoregulation, increasing the risk of heat-related illness, as children have reduced thermoregulatory capacity compared with adults during physical activity (Falk & Dotan, 2008).

Research by Vecellio et al. (2022), based on input from 55 experts with varying professional backgrounds, confirmed that thermal comfort is rarely prioritized in playground design. Yet, experts unanimously agreed that it should be considered a key factor alongside other safety criteria in relevant design guidelines and standards.

Sunlight exposure is also essential for playground safety, particularly in areas with sand, as sunlight acts as a natural "disinfectant" capable of reducing harmful bacterial populations. Oppezzo (2012) showed that UV-B radiation effectively inactivates bacteria by directly damaging their DNA. However, bacterial sensitivity to sunlight varies, and environmental factors such as humidity, temperature, and the presence of organic matter influence bacterial survival (Mika et al., 2009). To minimize contamination, sand areas should be enclosed by fences with gates. Research by Błaszak and Zatoń (2015) indicates that fencing reduces contamination from debris and plant material, although it does not fully eliminate the risk of bacterial contamination, such as *E. coli*, which may also result from improper human handling of sand. In the analyzed playgrounds, appropriate sunlight exposure and fencing particularly around sand areas were generally implemented, suggesting that safety in this regard has been adequately addressed.

Based on these findings, regular inspections and strict adherence to safety standards for equipment and surfacing are recommended. Studies by Beheshti et al. (2019) and Botsoglou et al. (2011) indicate that non-compliance with standards significantly increases the risk of injury. New playgrounds should be designed and constructed in accordance with current safety regulations, while older playgrounds built prior to the latest legal updates (Journal of Laws of 2023, item 2442) should be reviewed and retrofitted to meet current preventive safety requirements.

Thermal comfort, although crucial, is often overlooked in playground design (Vecellio et al., 2022). To address this, designers should prioritize the use of natural materials for both equipment and surfacing and incorporate greenery. Vegetation not only provides microclimatic benefits – shading and cooling the playground and equipment on hot days – but also supports creative forms of play. Care must be taken to eliminate potentially hazardous plant species, including those with toxic parts, spines, or sharp leaf edges.

The results of this study also indicate that contemporary playgrounds in Nowy Dwór deviate significantly from established safety standards, particularly regarding safety zones and loose-fill surfacing depth. Greater attention should therefore be devoted to both the design and maintenance of playgrounds, ensuring compliance with current laws and safety norms.

Although safety should remain a priority, design should not focus exclusively on minimizing risk. Overemphasis on safety can lead to playgrounds that are less engaging and less challenging, potentially limiting developmental benefits for children (Ball, 2004; Ball et al., 2019; Bundy et al., 2009; Wyver et al., 2010). A balanced approach is therefore recommended, integrating both safety and play value (Ball, 2004).

Playgrounds should be designed to provide engaging experiences that promote physical activity and social interaction while maintaining a reasonable level of safety. Educating children about safe behaviors and the consequences of risky actions is also essential. Morrongiello and Mark (2008) found that recalling past unsafe behaviors can reduce children's tendency to engage in risky play.

Children, as a population with distinct needs, often find standard playground solutions unengaging and short-lived (Khalilollahi et al., 2025). Therefore, playground design should aim to create a child-friendly environment that is safe, encourages physical activity, stimulates social interaction, and fosters creativity.

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CONCLUSIONS

The conducted study expands current knowledge regarding playgrounds and their spatial organization, particularly in relation to compliance with safety standards and environmental conditions. The analysis revealed that the surveyed playgrounds fail to meet numerous evaluated criteria. Notably, 100% of the sites had inadequate loose-fill surfacing, and safety zones around play equipment were improperly designated in 80% of cases. None of the playgrounds provided shaded areas in locations where play equipment is concentrated. Furthermore, over 75% of playgrounds remain exposed to direct sunlight during peak hours (10:00–14:00), which, in the context of climate change and heat waves, may pose health risks for children.

The findings also have important practical implications. They can guide playground managers in planning renovations and upgrades and serve as a valuable resource for designers by highlighting the relationships between different elements of playground design, safety, and user comfort.

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