

Article

A literature review on the design of children's outdoor play spaces from a child-friendly perspective combining biomechanics

Ke Chen^{1,2,*}, Ruhizal Bin Roosli¹, Yiyuan Zhao², Dong Wang²¹ School of Housing, Building and Planning, University Sains Malaysia, Penang 11800, Malaysia² Huaqing College, Xi'an University of Architecture and Technology, Xi'an 710000, China

* Corresponding author: Ke Chen, Dr.chenke@hotmail.com

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Abstract: The significance of outdoor games in the lives of children cannot be overstated, as outdoor play areas serve as vital laboratories for children to explore, imagine, and engage in social interactions. However, with the deepening of global urbanization, children's freedom to play in urban environments is becoming increasingly restricted. Simultaneously, the increase of urban residential density and the proliferation of indoor activity spaces has led to a considerable reduction in outdoor play areas for children. This diminished exposure to and interaction with nature indirectly impacts the physical and mental health development of children, giving rise to a host of physical and psychological issues. Outdoor play spaces serve as dynamic environments where children can connect with nature, understand their surroundings, and cultivate curiosity. The design of these spaces must prioritize biomechanics to enhance children's physical engagement and safety. High-quality outdoor play areas should be structured to promote movement that aligns with children's natural motor skills, facilitating activities that encourage running, climbing, and jumping. Such designs not only stimulate physical development but also foster cognitive growth by providing opportunities for problem-solving and creativity. This review summarizes excellent design concepts and methods for outdoor play spaces for children from multiple countries and regions in recent years, including 77 papers. It delves into the design principles of children's outdoor play spaces from a child-friendly perspective, taking into account children's needs, safety, and sustainability. This study focuses on providing scientific support for the optimization of outdoor play spaces for children, with particular attention to aspects such as the diversity of outdoor play spaces, stimulation of intelligence, and seamless integration of natural elements. The aim of this research is to enhance the quality of outdoor play spaces for children, improve children's outdoor play experiences, and promote children's healthy development. By applying biomechanical principles, designers can create environments that enhance children's interaction and exploration abilities, ultimately improving their overall quality of life. Emphasizing child-friendliness in the design of outdoor play spaces is crucial.

Keywords: child-friendly; biomechanics; outdoor play; design principles; spaces quality improvement

1. Introduction

Child-friendly refers to the promotion of children's holistic physical, intellectual, emotional and social development by providing a safe, healthy, equitable and inclusive environment. The child's friendly Angle is the characteristics of the child's physical and mental development stage, and fully guarantees their physiological and psychological needs. It is a concept and approach to meet the needs of children's growth and development, aiming to create favorable living environments and conditions to protect and promote children's rights [1–3]. As children's rights are

gradually being emphasized, the concept of child-friendliness has emerged and gradually developed into an important global concept of human rights governance. Child-friendly space is a concrete practice to implement the concept of child-friendliness, which is to give full consideration to children's needs in spatial design and planning in order to create a space suitable for children's growth and development [4–7].

Children are an important resource for the sustainable development of society and an important part of the social organizational structure, while outdoor play activities can create more opportunities for contact with the natural environment, stimulate children's creativity and imagination, and play an important role in promoting children's cognitive ability, cultivating their thinking and intellect, stimulating their imagination and interest, and enhancing their physical fitness [8–11]. In recent years, with the increase of social attention to children's education, the educational and inspirational role of outdoor games for children has been widely emphasized by people all over the world, and the design and construction of outdoor playgrounds have received more and more attention [12–14]. Therefore, children's outdoor play space design work is a kind of social responsibility that needs long-term improvement and development. With the development of the times, children's demand for outdoor play space is also growing and developing in the direction of diversification [15–17].

Outdoor play space is an indispensable part of every child's life, and is needed for children's personal growth and psychological development. The diversity and fun of outdoor play space under the concept of child-friendly can stimulate children's curiosity and creativity, and promote their physical and mental health and overall development. The literature [18,19] discussed China's situation. Literature [18] summarizes the significance of outdoor activities for children and points out the problems in the design of children's outdoor activity space. The information related to outdoor activity space is summarized and analyzed in terms of site design and green design, with a view to providing theoretical guidance for practice. Literature [19] emphasizes the importance of effective design of urban children's outdoor space to the landscape creation function of the city. The positive attributes of the environmental availability of children's parks were examined, and the results indicated that children's parks did not fully utilize their "recreational" function, and the available play opportunities were limited. Literature [20] describes outdoor play spaces in early childhood settings and examines the organization and use of scientific knowledge in outdoor environments. The results showed that most outdoor environments were unable to provide play opportunities for children because most of them had deficiencies. Literature [21] analyzed the narratives of young children's participation in outdoor play spaces, through which it was pointed out that spacious open environments have more distinctive features to develop children's well-being through play in good architectural equipment and privacy spaces, while overcrowded or artificial activity spaces are not conducive to children's health.

Children's development is related to the future of the nation, the country and the world, and children's daily life, personality development, and thought initiation are closely related to play, building a good outdoor play environment for children, and promoting children's all-round development through rich outdoor play space.

Literature [22] investigated children's perception of outdoor play, aiming to understand the characteristics that children like when they play. The findings indicated that most of the children's preferred features included natural landscapes, play, and diverse socialization, emphasizing the importance of appropriately designing and managing environmental features for children. Literature [23] discusses Canada and states that children's outdoor play spaces are mostly restricted by social and political practices and parental constraints on children's lives, which have changed the value of children's outdoor play spaces, and that children's lives have lost their "recreation" and have been replaced by academic programs. Literature [24] aims to investigate the design of outdoor play spaces and the incorporation of play features in "play spaces" to enhance children's social development. The results of the study demonstrated that the inclusion of play in the play space transformed the play space and promoted children's social and cognitive skills. Literature [25] reveals that outdoor play plays an important role in children's physical fitness, mental health, and social development. However, children's outdoor playtime is currently decreasing in China. Children's outdoor play experiences were summarized and a questionnaire survey was attempted in order to understand the relationship between play values and outdoor play space.

This study aims to explore and summarize the excellent concepts and methods in children's outdoor play space design from a child-friendly perspective in recent years, providing scientific support for optimizing outdoor play space design in cities. The ultimate goal is to enhance the quality of children's outdoor play spaces, improve their play experiences, and promote their healthy development.

2. Literature review

2.1. The concept and development of child-friendly cities

The concept of child-friendly cities (CFC) was proposed by the United Nations Children's Fund (UNICEF), aiming to ensure that children can enjoy safe, healthy, and beneficial living environments in cities. This concept emphasizes that urban planning and policy-making should fully consider the needs and rights of children, providing them with suitable living, learning, and recreational spaces [26].

The core of the child-friendly cities concept lies in safeguarding the physical and mental development of children. Research indicates that growing up in a child-friendly urban environment not only benefits children's physical health but also aids their psychological and social development. Such environments meet children's basic needs and promote their overall development by providing safe, accessible, and creative outdoor spaces [27].

Several cities worldwide have achieved significant success in implementing the child-friendly cities concept. For example, urban parks and outdoor recreational facilities in Japan focus on stimulating children's senses and imagination; urban planning in Denmark prioritizes safe walking and cycling paths, making it easier for children to engage in outdoor activities. These international cases provide valuable experiences and insights for other countries and regions.

2.2. The importance of children’s outdoor play spaces

Children’s outdoor play spaces have significant benefits for their physical health. Outdoor activities promote physical exercise, helping to strengthen the body, boost the immune system, and prevent health issues such as obesity. Additionally, outdoor play enhances the development of children’s fine and gross motor skills, aiding in their progress in physical fitness and coordination abilities.

Outdoor play is also crucial for children’s cognitive development. Outdoor play for young children is associated with positive health outcomes, with exposure to nature linked to psychological health [28], cognitive and social development, and fewer behavioral problems [29]. Studies show that exposure to natural environments can improve children’s attention, memory, and problem-solving abilities. In outdoor settings, children naturally learn scientific and mathematical concepts through exploration and observation, thereby enhancing their cognitive skills.

Moreover, outdoor play spaces provide important opportunities for social interaction among children. In these spaces, children can communicate, cooperate, and share with peers, developing their social skills and emotional intelligence. Through group play, children learn how to manage conflicts, build friendships, and develop empathy and teamwork.

2.3. Representative figures and their views in the field of children’s outdoor play space design

In the field of children’s outdoor play space design, several experts have made groundbreaking contributions, each bringing unique perspectives and methodologies to enhance the quality and effectiveness of these environments. Their work spans various aspects of design, from integrating natural elements and promoting diverse and flexible spaces to balancing safety with challenge and fostering social interactions. The following key figures exemplify these contributions (**Table 1**):

Table 1. The representative figures and their perspectives in the field of children’s outdoor play space design.

Name	Country	Design Perspectives
Robin Moore	USA	Emphasizes natural environment integration and diversity to promote physical activity and social interaction. Developed Behavior Mapping method.
Susan Herrington	Canada	Emphasizes developmental needs and play behaviors. Introduced ‘Seven Cs’ design principles: Challenge, Creativity, Connection, Change, Communication, Comfort, and Control.
Mitsuru Senda	Japan	Emphasizes flexibility and diversity in design to meet the needs of children of different ages. Integrates natural elements and ensures a balance between safety and challenge.
Karen Malone	Australia	Emphasizes designs should encourage interaction with nature to promote environmental awareness and physical health. Investigates the influence of natural environments on children’s outdoor play.
Helle Nebelong	Denmark	Emphasizes the importance of exploratory and challenging play spaces. Focuses on utilizing natural elements to create spaces that stimulate imagination and adventure.
Nicola Canning	UK	Emphasizes the need for designs that support social and emotional development. Studies the impact of outdoor environments on children’s play behavior and interaction.

Robin Moore (USA) is renowned for his “Behavior Mapping” method, which has profoundly influenced the integration of natural elements and diverse design in play environments. Susan Herrington (Canada) introduced the “Seven Cs” design principles, which are pivotal in research on child development and play behavior, and

widely recognized in both academic and practical contexts. Mitsuru Senda (Japan) emphasizes the importance of flexibility and diversity in playground design, with significant contributions to balancing safety and challenge in both domestic and international projects. Karen Malone (Australia) has extensively studied the effects of natural environments on children's play, advocating for designs that promote interaction with nature, thus enhancing environmental awareness and physical health [30]. Helle Nebelong (Denmark) offers a unique perspective on using natural elements to create exploratory and challenging play spaces, a concept widely adopted in Nordic countries. Nicola Canning (UK) focuses on the impact of outdoor environments on children's social and emotional development, optimizing design through observational research, although her practical application is relatively less extensive.

By comparing their viewpoints, we can distill nine key design principles for creating effective and engaging children's play spaces:

- 1) Integration of natural elements: Leveraging natural features to enhance sensory experiences and engagement.
- 2) Diversity and flexibility: Ensuring varied and adaptable play environments to cater to different needs and interests.
- 3) Balance of safety and challenge: Designing spaces that offer safe yet stimulating challenges to support development.
- 4) Promoting social interaction: Creating environments that facilitate socialization and cooperative play.
- 5) User participation in design: Involving children and community members in the design process to ensure relevance and inclusivity.
- 6) Cultural and community Background: Reflecting cultural and community contexts in the design to foster a sense of belonging.
- 7) Promoting creativity and imagination: Encouraging imaginative and creative play through innovative design features.
- 8) Accessibility and inclusivity: Designing play spaces that are accessible and welcoming to all children, regardless of ability.
- 9) Environmental education: Incorporating elements that educate children about the environment and promote sustainable practices.

3. Research methodology

To collect academic research on child-friendly outdoor play space design, this research conducted a literature search in major full-text academic databases, including Web of Science, Science Direct, JSTOR, EBSCOhost, and ProQuest. My goal was to identify excellent concepts regarding the design of children's outdoor play spaces globally. These studies focus on themes such as design principles, child development, integration of natural elements, safety, and diversity.

To achieve this goal, using the following keywords: "child-friendly", "outdoor activities", "outdoor play space", "playground", "park design", "environmental design" and "landscape design" combined with terms related to the nine design principles such as "child development", "safety", "accessibility", "diversity" and "natural environment". The search results yielded 77 papers that met these criteria. By reviewing the references of these 77 papers and several related review articles, this

article categorized these papers according to design principles. All these articles were published in peer-reviewed journals in fields such as urban planning, landscape design, child development, and public health.

4. Analysis and discussion

This section categorizes and discusses the literature related to the nine design principles: Integration of Natural Elements (**Table 2**), Diversity and Flexibility (**Table 3**), Balance of Safety and Challenge (**Table 4**), Promoting Social Interaction (**Table 5**), User Participation in Design (**Table 6**), Cultural and Community Background (**Table 7**), Promoting Creativity and Imagination (**Table 8**), Accessibility and Inclusivity (**Table 9**), and Environmental Education (**Table 10**). Each principle is closely related to promoting children’s healthy growth and development, taking the principle of Integration of Natural Elements as an example as followed.

Table 2. Sampled articles categorized by principle of natural elements integration.

Author (s)/Year	Country	Focus
Mozaffar and Mirmoradi, 2012 [31]	Iran	Integration of natural elements in educational spaces to enhance social interaction and play.
Cengiz and Boz, 2019 [32]	Turkey	Use of biophilic design to create sustainable playgrounds that incorporate plants and natural elements.
Fenclová, 2020 [33]	Sweden	Impact of integrating natural elements on children’s emotional connection with nature.
Adina et al., 2018 [34]	Canada	Behavior mapping to understand the role of natural elements in children’s outdoor activities.
Jeon and Jun, 2021 [35]	South Korea	Developing design criteria that incorporate natural elements to enhance children’s movement skills and perception.
Nedovic and Morrissey, 2013 [36]	Australia	Children’s responses to organic outdoor learning environments that include natural materials.
Cheng, 2021 [37]	China	Incorporating children’s ideas and natural elements into the design of outdoor play spaces.
Herrington and Brussoni, 2015 [38]	Canada	Importance of nature-based play spaces for children’s health and development.

The high-density urban living model and the prevalence of indoor activity spaces have led to insufficient outdoor play for children, resulting in “Nature Deficit Disorder”, which has profound impacts on children’s physical and mental health. Research shows that reduced contact with nature can lead to a range of physical and psychological issues in children [39], such as attention deficit hyperactivity disorder (ADHD), obesity, and emotional disorders. Additionally, the lack of opportunities for interaction with nature can hinder the development of children’s cognitive and social abilities.

The integration of natural elements in the design of children’s outdoor play spaces is of significant importance, as it not only provides rich sensory experiences but also stimulates children’s curiosity and desire to explore. Literature indicates that natural elements such as trees, grass, water features, and gardens offer children opportunities to engage with nature, thereby promoting their physical and cognitive development. For instance, Robin Moore’s “Behavior Mapping” method emphasizes studying children’s activity patterns through the integration of natural elements to design more attractive and educational play spaces. Susan Herrington also points out that the

introduction of natural elements can enhance the diversity and flexibility of play spaces, benefiting children’s development. Karen Malone’s research further supports this view, highlighting that designs encouraging interaction with nature not only aid in environmental education but also improve children’s environmental awareness and physical health. Helle Nebelong, through the use of natural elements in design, creates exploratory and challenging play spaces that promote children’s autonomous exploration and problem-solving abilities. In the case of successful review, the integration of natural elements in space allows children to relax fully in the process of outdoor games.

Table 3. Sampled articles categorized by principle of diversity and flexibility.

Author (s)/Year	Country	Focus
Raney et al., 2023 [40]	USA	Examining how diverse and nature-based design features in schoolyards affect children’s play behaviors.
Jeon and Jun, 2021	South Korea	Developing playground design criteria to enhance children’s fundamental movement skills and perceptual abilities.
Herrington and Lesmeister, 2006 [41]	Canada	Emphasizing the importance of diversity and flexibility in childcare center landscapes.
Sterman et al., 2019 [42]	Scandinavian countries	Investigating government and family decision-making in planning outdoor play spaces with a focus on diversity and flexibility.
Woolley, 2008 [43]	UK	Designing public play spaces with a focus on diversity, clarity, and flexibility.
Moore et al., 2022 [44]	USA	Supporting outdoor play, social participation, and inclusion through universal design principles.
Lynch and Wishart, 2021 [45]	UK	Redeveloping school play spaces with a focus on play diversity and student agency.
Zamani, 2016 [46]	UK	Investigating cognitive play opportunities in different types of outdoor environments.
Lynch et al., 2019 [47]	Ireland	Addressing play diversity and inclusion in community parks and playgrounds.
Parsons, 2011 [48]	USA	Examining the relationship between outdoor play,
Walsh, 2016 [49]	Australia	Planning outdoor learning environments with a focus on diversity and flexibility.

Table 4. Sampled articles categorized by principle of balance of safety and challenge.

Author (s)/Year	Country	Focus
Boon, 2020	Netherlands	Design strategies for promoting physical activity while balancing safety and challenge in play areas.
Jeon and Jun, 2021	South Korea	Developing design criteria to enhance movement skills and perception while balancing safety and challenge.
Herrington and Lesmeister, 2006	Canada	Emphasizing diversity and flexibility in childcare center landscapes to create challenging play opportunities.
Tim Waller and Maynard, 2010 [50]	UK	Balancing children’s interests and providing new challenges in early childhood outdoor spaces.
Woolley, 2008	UK	Designing public play spaces with challenging settings that promote balance and coordination.
Spiegel et al., 2014 [51]	UK	Rethinking play equipment standards to balance safety management and play challenges.
Clements, 2004 [52]	USA	Investigating the status and safety concerns of outdoor play for children in the USA.
Cheng, 2021	China	Incorporating children’s ideas into play space design to balance challenge and safety.
Parsons, 2011	USA	Exploring outdoor play, environmental consciousness, and playground design implications.
Walsh, 2016	Australia	Planning early childhood playgrounds that balance developmental needs and challenging play.

Table 5. Sampled articles categorized by principle of promoting social interaction.

Author (s)/Year	Country	Focus
Boon, 2020	Netherlands	Design strategies to promote physical activity and social interaction in play areas.
Wray et al., 2020 [53]	USA	Review of interventions in outdoor spaces to promote physical activity and social connectedness.
Miranda, 2016 [54]	Spain	Impact of outdoor environments on preschool children's social play.
Hitron et al., 2018 [55]	Israel	Benefits and risks of digital outdoor play in promoting social interaction.
Safari, 2022 [56]	Iran	Role of green playgrounds in enhancing children's social interactions.
Brussoni et al., 2017 [57]	Canada	Interventions to promote nature-based risky play and social interaction.
Moore et al., 2022	Ireland	Universal design for supporting outdoor play, social participation, and inclusion.
Back et al., 2018 [58]	Sweden	Interaction and emerging play in outdoor play installations.
Kamal and Gabr, 2023	Egypt	Play space design to enhance children's social and cognitive development.
Helen Woolley and Lowe, 2012 [59]	UK	Relationship between design approach and play value in outdoor play spaces.

Table 6. Sampled articles categorized by principle of user participation in design.

Author (s)/Year	Country	Main View
Ensarioğlu, 2021 [60]	Turkey	Emphasizes the need for children's participation in urban planning to design inclusive play areas.
Moore et al., 2023 [61]	UK	Reviews how universal design principles can be utilized to create inclusive public playgrounds.
Jansson and Persson, 2010 [62]	Sweden	Evaluates playground planning and management based on user needs and participatory approaches.
Ripat and Becker, 2012 [63]	USA	Examines playground usability from the perspectives of users to enhance design.
Slingerland et al., 2020 [64]	Netherlands	Presents a participatory design approach to support children in co-creating outdoor play activities.
Ensarioğlu, 2021	Turkey	Focuses on engaging young users in the design process to create play areas that cater to various play scenarios.
Reinhardt et al., 2023 [65]	USA	Enhances playground design to accommodate blind and low-vision children, improving access and play experiences.
Sekulova and Mallén, 2024 [66]	International	Involves children as decision-makers in the design and utilization of naturalized schoolyard areas.
Batenipour, 2023 [67]	International	Designs child-friendly outdoor public playgrounds using a co-creation approach with children.
Oğul, 2016 [68]	Bulgaria	Investigates teachers' practices in utilizing outdoor play and learning spaces to support children's mathematical development.
Janpavle and Ile, 2023 [69]	Latvia	Focuses on the quality evaluation of active leisure areas and their integration into children's playgrounds for promoting social inclusion.

Table 7. Sampled articles categorized by principle of cultural and community background.

Author (s)/Year	Country	Focus
Avis Ridgway, 2021 [70]	Australia	Examining toddlers' outdoor play and cultural formation.
Wood et al., 2019 [71]	UK	Designing outdoor play spaces from cultural and traditional perspectives.
Martinsen, 2010 [72]	Norway	Investigating the outdoor environment in Norwegian kindergartens as a pedagogical space.
Sterman et al., 2019	Scandinavian countries	Studying government and family decision-making in planning outdoor play spaces.
Prince et al., 2014 [73]	Various countries	Exploring outdoor play and learning in early childhood from different cultural perspectives.

Table 7. (Continued).

Author (s)/Year	Country	Focus
Loebach and Cox, 2022 [74]	Canada	Examining environmental features and conditions that support diverse outdoor play activities.
Rockquemore, 2014 [75]	USA	Building healthy communities and preserving culture through
Demir et al., 2021 [76]	Turkey	Connecting indoor and outdoor spaces in children’s playgrounds.

Table 8. Sampled articles categorized by principle of promoting creativity and imagination.

Author (s)/Year	Country	Focus
Boon, 2020; DEMİR et al., 2021	Netherlands	Design strategies to promote physical activity and imaginative play in children.
Shafaei, 2017 [77]	Iran	Correlations between imagination, curiosity, cooperative play, and physical factors to enhance creativity.
Undeyoglu, 2023 [78]	Turkey	Revitalizing outdoor play areas to encourage imaginative play and introduce challenges.
Woolley, 2008	UK	Designing public play spaces to promote creativity and imaginative play.
Kamal and Gabr, 2023	Egypt	Play space design to enhance children’s social and cognitive development.
Mariana Brussoni et al., 2017	Canada	Promoting nature-based risky play to enhance creativity and self-confidence.
Mullick, 2013 [79]	USA	Developing inclusive design guidelines for play spaces.
Ernst and Burcak, 2019 [80]; Mullick, 2013	USA	Influence of nature play on curiosity, executive function skills, creative thinking, and resilience.
Khalilolahi et al., 2015 [81]	Iran	Designing urban environments to promote children’s creativity.
Dowdell et al., 2011 [82]	Australia	Influence of nature on children’s outdoor play and imagination.
Dylan et al., 2021 [83]	UK	Using digital resources to inspire preschool children’s free play and creativity.
Mahony, 2018 [84]	Australia	Exploration of contrasting school equipment provisions to develop creativity through outdoor activities.
Parsons, 2011	USA	Impact of outdoor play on environmental consciousness and playground design.
Wilson, 2008 [85]	USA	Encouraging creative play and learning in natural environments.
Mahony, 2018	UK	Extending creative learning in the early years through outdoor play.

Table 9. Sampled articles categorized by principle of accessibility and inclusivity.

Author (s)/Year	Country	Focus
Ismal et al., 2023 [86]	Malaysia	Investigating criteria for inclusive playgrounds for children with disabilities.
Michela, 2020 [87]	Italy	Assessing the reality of inclusive playgrounds in cities.
Taylor et al., 2023 [88]	Canada	Evaluating tools for assessing inclusivity in playgrounds.
Taylor et al., 2022 [89]	Canada	Protocol for evaluating playground inclusivity for children with disabilities.
Dalki, 2023 [90]	USA	Increasing access to outdoor play for families with children with disabilities.
Lynch et al., 2019	UK	Addressing play diversity and inclusion in community parks.
Bould and Bezerra, 2011	Canada	Exploring abilities and inclusivity in playground design.
Derr and Tarantini, 2016 [91]	USA	Outcomes from young people’s participation in planning child-friendly spaces.
Trudeau, 2024 [92]	Canada	Equity issues in natural playground usage and development.
Lynch et al., 2018 [93]	Ireland	Intergenerational participation in community parks through universal design.
Van Melik and Althuisen, 2020 [94]	Netherlands	Access policies for disabled children in Dutch playgrounds.
Jeanes and Magee, 2012	UK	Creating inclusive play spaces for disabled young people.
Ripat and Becker, 2012 [95]	USA	Usability and inclusivity from playground users’ perspectives.

Table 9. (Continued).

Author (s)/Year	Country	Focus
Dalpra, 2022 [96]	Italy	Rethinking play environments for social inclusion.
Moore et al., 2022	Ireland	Supporting outdoor play and inclusion through universal design.
Yildirim et al., 2022 [97]	Turkey	Case study on inclusiveness of play-based experiences.
Dong, 2023 [98]	USA	Recommendations for inclusive early childhood learning spaces.
Michela, 2020	Netherlands	Promoting social inclusion through inclusive playground design.

Table 10. Sampled articles categorized by principle of environmental education.

Author (s)/Year	Country	Focus
Mozaffar and Mirmoradi, 2012	Iran	Design strategies for incorporating nature into educational spaces.
Acar, 2014 [99]	Turkey	The importance of environment in education and the impact of outdoor spaces.
Nordén and Avery, 2020 [100]	Sweden	Sustainability education through redesigning outdoor spaces in preschools.
Helen Woolley and Lowe, 2012	UK	Relationship between design approach and play value in outdoor play spaces.
Byrd et al., 2007 [101]	USA	Creating outdoor learning labs for environmental education using water gardens.
Herrington and 1998 [102]	Canada	Innovative landscape interventions for designing children's play environments.
Malone, 2004	Australia	Creating supportive spaces for children's environmental learning.
Cooper, 2015 [103]	USA	Utilizing the outdoor learning environment in early childhood education.
Yilmaz, 2016	Turkey	Impact of outdoor play environments and activities on children's development.
Kellie Dowdell et al., 2011[104]	Australia	Influence of nature on children's outdoor play.
Ardoin and Bowers, 2020 [105]	USA	Systematic review of research literature on early childhood environmental education.
Freuder, 2006 [106]	USA	Promoting Eco literacy through design of children's outdoor play environments.

The development of child-friendly cities varies in focus across different countries and regions, with each implementing specific design principles and practices that offer valuable insights for global child-friendly city construction, **Figure 1** is shown the distribution of literature references by country on children's outdoor play space. In the United States, the emphasis is on balancing safety and challenge, diversity and flexibility, and user participation in design, enhancing the practicality and attractiveness of play spaces through safety standards and community involvement. Sweden prioritizes promoting social interaction, integrating cultural and community backgrounds, and ensuring accessibility and inclusivity, ensuring that all children can equally participate in and benefit from play. Germany excels in environmental education and the integration of natural elements, fostering children's environmental awareness through the extensive use of natural features and sustainable design. China's design increasingly focuses on cultural integration, community interaction, and environmental education, emphasizing the combination of local cultural elements and environmental themes. India focuses on accessibility and inclusivity, balancing safety and challenge, and user participation in design, ensuring the safety and inclusivity of play spaces even with limited resources. Japan creates adaptable play spaces that meet diverse needs and cultural backgrounds through flexibility and diversity in design, cultural and community integration, and the incorporation of environmental education and natural elements. The United Kingdom contributes significantly to promoting social interaction, integrating environmental education and

natural elements, diversity and flexibility, and ensuring accessibility and inclusivity through diverse design and accessible facilities, supporting the holistic development of all children.

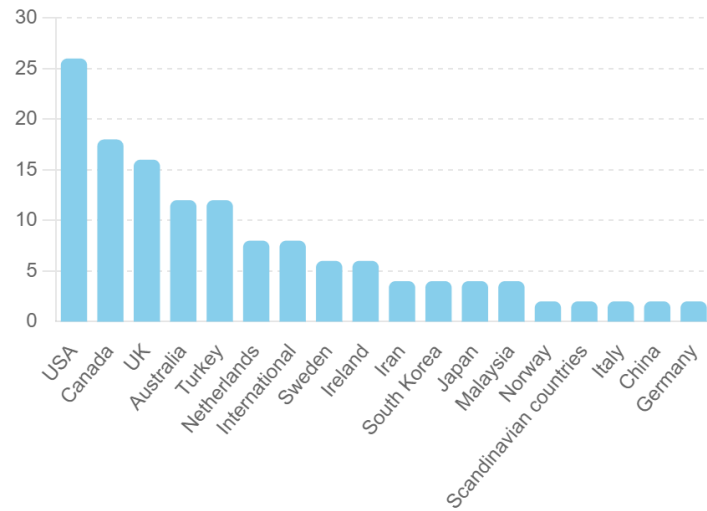


Figure 1. Distribution of literature references by country on children's outdoor play space.

The bar chart reflects the 77 references sampled, comprehensive visualization showcases the distribution of literature references across different countries, highlighting the contributions from developed nations in the field of children's outdoor play space design. Besides these theoretical studies, several practical cases are worth referencing. Berlin's Tiergarten Park in Germany utilizes abundant natural elements, creating opportunities for children to engage with nature, thereby promoting their physical and mental health and cognitive development. Speelpark de Splinter in the Netherlands achieves a dynamic and challenging play environment through flexible and diverse facility layouts, encouraging children's creativity and problem-solving skills. West Coast Park in Singapore features rope climbing frames and slides that meet safety standards, sparking children's adventurous spirits while ensuring their safety. Vasaparken in Sweden includes large sandpits, basketball courts, and soccer fields, fostering social interaction among families and community members. Adventure Playground in Berkeley actively involves children and community members in the design process, ensuring that the play space meets actual needs and is highly popular.

Summarizing the experiences of these countries reveals that the nine design principles—Integration of Natural Elements, Diversity and Flexibility, Balance of Safety and Challenge, Promoting Social Interaction, User Participation in Design, Cultural and Community Background, Promoting Creativity and Imagination, Accessibility and Inclusivity, and Environmental Education—are widely recognized and applied globally. Each region should adapt these principles based on their cultural context and geographical characteristics to create safer, healthier, more inclusive, and educational child-friendly urban environments.

5. Conclusion

The development of child-friendly outdoor play spaces is crucial for fostering the

physical, cognitive, social, and emotional well-being of children. This literature review highlights the key design principles essential for creating effective and engaging play environments. These principles include the integration of natural elements, ensuring diversity and flexibility, balancing safety and challenge, promoting social interaction, involving users in the design process, incorporating cultural and community backgrounds, fostering creativity and imagination, ensuring accessibility and inclusivity, and emphasizing environmental education.

The future design of child-friendly outdoor play spaces should focus more on environmental protection, sustainable development, green technology, digital construction and management, as well as biodiversity and ecological experiences. In terms of environmental protection, efforts should be made to preserve natural ecosystems, use eco-friendly materials, introduce green infrastructure, and achieve energy and water self-sufficiency through renewable energy and smart irrigation systems. Additionally, adopting circular design can reduce resource waste. In digital construction and management, smart monitoring and management technologies should be used to ensure environmental health and resource efficiency, maintaining optimal facility operation. Interactive educational facilities and virtual reality technologies can enhance children's environmental awareness and responsibility while providing personalized learning experiences. Regarding biodiversity and ecological experiences, creating micro ecological reserves, ecological exploration routes, and interactive ecosystems can help children learn and understand the importance of biodiversity through play. By integrating these measures, we can not only create healthier and safer play environments but also contribute to a greener and more sustainable future.

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