



Research article

Data analysis and spatial design study of children's activity sites in rural Gansu, China

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Abstract: This paper examined rural outdoor activity sites for children in Zhangye, Gansu Province, China. The study analyzed the characteristics of children's groups and their behavioral patterns during outdoor activities in rural areas, and explored the factors affecting children's engagement in outdoor activities. A questionnaire survey was conducted to assess the physical and mental health status of rural children in Gansu Province, the distribution of outdoor activity time, and the influence of activity venues on children. Based on the survey results in rural Zhangye, Gansu Province, activity venues and facilities suitable for rural children in Gansu were identified. Finally, five design principles were proposed (i.e., safety, fun, comfort, accessibility, and guiding) to cater to the activity preferences of rural children in Gansu, China and provide a nurturing environment that fostered their physical and mental growth.

Keywords: rural children; children's activity characteristics; outdoor activity space design; left-behind children; behavioral maps

1. Introduction

Gansu is a province located in the northwest of China, situated at the intersection of three major plateaus, and its economy is relatively backward compared to the more affluent eastern coastal cities. As of the end of 2021, the resident population of Gansu Province was 24,900,200, with 119,524,999 rural residents accounting for 47.77%, and the province's transient population was 45,759,474, with 5,124,793 of them aged 0–15 years old [1–3]. There are 1,229 townships in the province,

including 892 towns, 305 townships, and 32 ethnic townships. According to the sixth sports ground census data, there were 18,236 rural sports grounds in the province.

Children's physical and mental health [4] and growth are becoming increasingly important concerns for parents of Chinese children. According to the data from China's seventh national census, there are a total of 253,380,000 children between the ages of 0–14 years, which shows an increase compared to the figure of 222,460,000 children recorded in China's sixth national census. This rise in numbers has led to an increase in the percentage of the total number of children in the population from 16.60% in the sixth census to 17.95%. China's Children's Development Program (2011–2020) has set the development goal of building a child-friendly society, and the study of the spatial characteristics of rural children's daily life is integral to promoting rural communities and building a child-friendly society. The program introduces a new dimension for measuring children's social and public services and the allocation of public resources [5]. The social development and [6,7] daily life environment of rural children are crucial aspects of their physiological and psychological growth. Investigating the spatial characteristics of their lives can help us comprehend the temporal and spatial patterns of their daily routines. The study of the interaction between rural children's lives and the surrounding rural space's natural environment and infrastructure provides a basis for the construction of a conducive rural environment for their well-being [8].

According to Figure 1, the latest data from the National Health and Wellness Commission of the People's Republic of China shows that the overall myopia rate among children and adolescents across China is projected to reach 52.7% in 2020, with more than half of children and adolescents having myopia problems, an increase of 2.5% compared with 2019. Among them, the myopia rate of 6-year-old children reaches 14.3%, 35.6% at the elementary school level, 71.1% at the junior high school level, and 80.5% at the senior high school level, while the proportion of middle-level and high-level myopia is nearly 50% [9]. According to Figure 1 in China National Mental Health Development Report (2019–2020), the detection rates of depression in elementary, middle, and high school were 10%, 30%, and 40% respectively, with the corresponding detection rates of severe depression being 1.9–3.3%, 7.6–8.8%, and 10.9–12.5%, respectively.

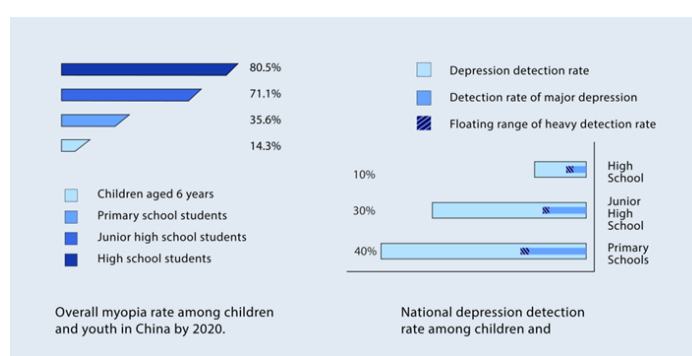
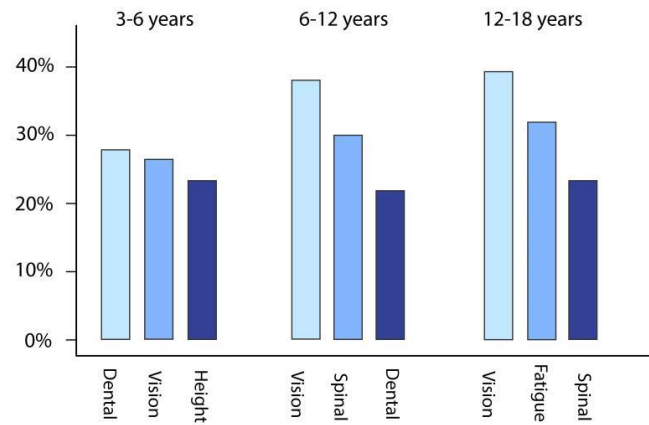


Figure 1. Overall myopia rate among children and youth in China by 2020 (left). National depression detection rate among children and adolescents in China by 2020 (right).

According to a survey of parents in the villages and towns of Yunuan, Banqiao, Shahe, and Pingchuan in Zhangye City, Gansu Province, most parents expressed concerns about their children's

physical and mental health. As shown in Figure 2, parents were most worried about children's vision, spine, and mental health problems. Among them, 27% of parents with kindergarten children, 38% of parents with primary school students, and 39.5% of parents with secondary school students expressed concern about vision problems, and the level of parental concern increased with the age of the children. For spinal problems, 23.8% of parents with kindergarten children, 30% of parents with elementary school students, and 25.3% of parents with middle school students expressed concern.



The most important concerns of parents of children of different ages about their children's physical and mental health in Gansu, China.

Figure 2. The most important concerns of parents of children of different ages about their children's physical and mental health in Gansu, China.

Compared with the children in urban areas, most of the left-behind children in the countryside [10] experience psychological issues because of the lack of emotional communication with their parents who have migrated for work. This often results in low self-esteem, fear of failure, and reluctance to express themselves in public. They frequently perceive themselves as inferior to other children and may even blame themselves for their mistakes. For these children, it is essential to fully acknowledge their abilities, offer timely encouragement, nurture their self-confidence, and actively guide them to express their feelings, enabling them to overcome fear and develop a balanced perspective on success and failure. According to Figure 3, parents have proactively implemented various measures to address the physical and mental health challenges faced by their children. Moderately increasing the time children spend on exercise emerged as the most popular measure. Encouraging children to take breaks or gaze into the distance after extended use of their eyes ranked third across all age groups. Additionally, providing children with nutritional supplements, purchasing study desks and chairs to promote proper posture, and regulating study time and electronic device usage collectively ranked as the second most common measures for all age groups [11,12].

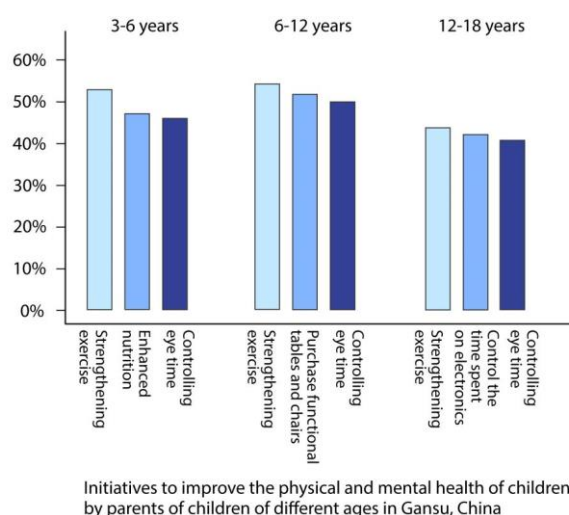


Figure 3. Initiatives to improve the physical and mental health of children by parents of children of different ages in Gansu, China. (Image data was obtained from the author's questionnaire).

As urbanization continues to expand in China, children's access to nature is rapidly diminishing, particularly in Gansu Province. This region, although economically underdeveloped, faces challenges for children to engage in outdoor recreation due to its arid, sandy, and dusty climate. Despite rural areas theoretically offering more opportunities for children to interact with nature, they actually have limited exposure to it due to climatic constraints [13]. According to the natural disaster data released by the National Bureau of Statistics of Gansu Province, in 2022, 169,600 hectares were affected by drought, 105,200 hectares were impacted by hail and wind, and 153,400 hectares were affected by freezing temperatures and snowstorms. In 2021, the drought-affected area in Gansu Province reached a staggering 410,000 hectares. According to my preliminary research on the villages and towns of Yunuan, Banqiao, Shahe, and Pingchuan in Zhangye City, Gansu Province, children in these areas face challenges in their daily outdoor activities due to the impact of drought, wind, hail, and snowstorms, despite having ample space available for recreation. Despite the children's efforts to engage in various outdoor activities, such as playing games, collecting and creating leaf specimens, and gathering tree branches, their frequency and quality were restricted by climatic factors [14]. This indicates that, in addition to the effects of urbanization, children in Gansu Province encounter a common challenge of limited exposure to nature due to climatic, familial, and psychological factors. Therefore, enhancing children's connection with nature necessitates addressing a combination of urbanization, climatic, familial, and psychological aspects to create a more conducive environment for unleashing their natural instincts.

In the villages and towns of Zhangye City, Gansu Province, such as Yanuan Town, Banqiao Town, Shahe Town, and Pingchuan Town, there are many left-behind children. These rural children should have more opportunities to interact with nature compared to their urban counterparts. However, due to social and family reasons, some children in rural areas are taken care of by their grandparents because their parents go out to work, which can result in problems with their psychological development, although their basic material needs are usually met. These rural children tend to be introverted,

preferring to be alone and avoiding socializing with their peers. They may also believe that playing alone is better than playing with others [15]. In order to overcome the previously mentioned issues, the design of rural activity venues should take into account the problems of this type of rural children. The goal is to encourage more interaction with others so that their interpersonal skills can improve over time.

The author analyzed several squares in the townships of Yanuan Township, Banqiao Township, Shahe Township, and Pingchuan Township in Zhangye City, Gansu Province, and found that several behavioral and psychological characteristics could be commonly observed in children. First, children have a natural inclination to play. Second, they tend to imitate the people and things around them, akin to Mencius as a child. Third, children display curiosity and a keen interest in new things. Fourth, they have a strong desire for success. Fifth, children are inclined to engage in group activities with their peers and appreciate praise from parents, teachers, and elders. Therefore, it is crucial to deeply analyze and understand these behavioral and psychological traits when designing public spaces for children [16]. Only through targeted design based on children's psychological needs can we better meet children's own needs and positively influence their physical and mental health.

2. Methods

2.1. Problems of activity space in villages and towns in Gansu province

As shown in Figure 4, according to China's Sixth Census of Sports Venues, the types of sports venues in the whole of China can be categorized into 84 types, while there are now 52 types in Gansu Province, with the number of urban sports venues amounting to 10,246 and the number of rural sports venues amounting to 18,236. According to the latest population data of Gansu Province in 2022 and the Sixth Census of Sports Venues, Gansu Province has a total resident population of 24,920,000. Among them, the urban population is 13,510,000, accounting for 54.21% of the total population, and the existing rural population is 11,410,000, accounting for 45.79% of the total population. The total area of sports venues is 28,917,500 m², of which 15,097,000 m² are in cities and towns, accounting for 52.21% of the total sports venue area, and 13,820,500 m² are in rural areas, accounting for 47.79% of the total sports venue area. The number of sports venues and facilities owned by urban residents was 8.91 per 10,000 people, and the number of sports venues and facilities owned by rural residents was 15.98 per 10,000 people. The average area of sports venues available to each urban resident was 1.12 m², and that of rural areas was 1.21 m². First, in terms of the number of sports venues and the area of sports venues available per capita, there are more in rural areas than in towns, but most of the rural sports venues and facilities are farmers' sports and fitness projects or national fitness paths (e.g., Figure 5), and there are almost no activity venues that can be used normally [17]. Second, as in Figure 6, local villages and towns are built along the highway, which passes through the town, and the vehicles are constantly coming and going, and most of them are agricultural vehicles, which is a concern for safety. Therefore, there are only a few activity sites that can guarantee children's play in rural Gansu province.

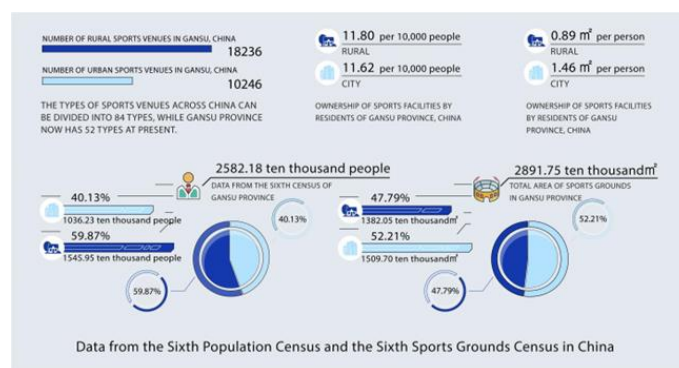


Figure 4. Data from the Sixth Population Census and the Sixth Sports Grounds Census in China.



Figure 5. Status of sports facilities in the town.



Figure 6. Status of roads within the town.

Based on the control of boundaries and spatial functions in activity areas, outdoor spaces for children can be categorized into single-type spaces that allow free access, with no clear function division and a weak sense of boundary; multi-functional combination spaces; and composite-type spaces with lower degrees of mutual interference between each space. According to the service objectives, these spaces can be further divided into city parks, community parks, campus plazas, city streets and plazas, and so on.

At present, most of the outdoor children's activity spaces in Gansu rural areas [18] are not designed in terms of the growth and psychology of rural children. From the viewpoint of the current situation of the venue space in rural Gansu Province (Table 1), the main problems include the single function of the venue, the simple type, the lack of utilization of vertical space, and the space boundaries that are still mainly controlled by plants and seats. From the point of view of site characteristics, the

overall monotonous color cannot stimulate children's senses and is difficult to attract children; local cultural elements are not reflected in the site, and there is a lack of activity facilities for children to play. From the perspective of humanization, there is no barrier-free design, the facilities such as tree pools in the site are angular and less safe, the sports facilities are old, the design of the site and facilities does not meet the children's physiological scale, and the lack of a sense of enclosure of the space is not in line with the children's physiological and psychological needs; the ground pavement is mainly square bricks and concrete, the texture of which is hard compared to the safety of the pavement of plastic materials and so on; and the accessibility of space is poor, although it is not necessary to have special facilities like urban parks, which cannot stimulate children's senses and attract them. Although it is not necessary to provide specialized bus stops like those in city parks, outdoor children's activity spaces can include designated parking areas with appropriate amounts of parking space. From the viewpoint of landscape design, there may be poor space orientation and recognition, making it difficult for children to navigate. The vegetation in these spaces may be monotonous and prone to damage, consisting mostly of shrubs with disorganized growth. The dominant color is typically green, with limited variety in ornamental plants. These factors can somewhat hinder children's ability to connect with nature [19].

Table 1. The main problems of outdoor activity areas in rural Gansu.

The main problems of outdoor activity areas in rural Gansu	Survey of current status
<p>The site is functional and simple, with no use of vertical space, and the spatial boundaries are mainly controlled by plants and seating.</p> <p>In terms of the characteristics of the site, the overall colors are monotonous and do not stimulate the children's senses, which makes it difficult to attract children; local cultural elements are not reflected in the site and there are no facilities for children to play.</p> <p>From a humanistic point of view, there is no barrier-free design, the facilities such as the tree pond in the site are angular, the ground paving has a hard texture and poor safety; the sports facilities are old, the design of the site and facilities does not conform to the physiological scale of children, the space lacks a sense of enclosure and does not meet the physiological and psychological needs of children; the accessibility of the space is poor.</p> <p>In terms of landscape design, the space is poorly oriented and recognizable, making it difficult to guide children into the area; the vegetation is monotonous and mostly green in color, with very few unique and ornamental plants and serious damage, which to a certain extent affects children's natural inclination to get close to nature.</p>	<p>Research villages and towns: 4</p> <p>Photographs taken: 1241</p> <p>Interviewed residents: 62</p> <p>Formed questionnaires: 59</p>

The development of the city, as well as social progress, prompted people to pay more attention to the impact of the living environment on their own but neglected to pay attention to the impact of the living environment on children's growth as a group, making the current design of outdoor children's activities space in China there are many problems. First, the design of many outdoor children's activity spaces mostly stays in the construction of infrastructure, and not according to the children's own needs and local characteristics, designing activity spaces and activities that meet the characteristics of

children's activities [20], ignoring the emotional connection between children and activity spaces [21]. Second, due to the continuous expansion of the urban area, the rural area has been gradually occupied, and some places that can provide outdoor activities for children are gradually disappearing. Third, most of the current outdoor children's activity venues are designed according to the body scale of adults, which is not in proportion to the body scale of children. The choice of materials, space enclosure, and safety of facilities lack careful consideration, and uniformity, resulting in the use of children inconvenience, and poor safety. It fails to effectively facilitate children's social interaction. Furthermore, there is insufficient consideration given to the experiential aspects, interaction opportunities, and emotional elements of outdoor children's activity venues. This lack of attention to cultural factors results in a diminished sense of connection between children and their local culture, thereby neglecting their psychological and spiritual needs.

2.2. Characteristics and types of children's activities in rural Gansu province

The data for this survey was collected from February 20 to 26, 2023, over a period of one week, focusing on the daily lives of children aged 6–12 years in Yanuan, Banqiao, Shahe, and Pingchuan townships in Zhangye City, Gansu Province. A total of 51 children and their parents participated, and 43 valid questionnaires were returned. Among the respondents, there were 16 boys and 27 girls, with varying numbers in each age group (2, 3, 7, 5, 4, 11, and 11 children, respectively). Prior to developing the questionnaire, a preliminary pre-survey had been carefully conducted to gather initial insights into rural children's daily activities. The pre-survey deliberately avoided imposing any preconditions that could influence the results, allowing respondents to provide feedback on various aspects. This pre-survey aimed to enhance understanding of the diversity of rural children's daily activities and lay the foundation for categorizing and summarizing these activities. With this groundwork, the questionnaire was designed to ensure methodological rigor, scientific validity, and alignment with the nuanced aspects of rural children's daily lives in different contexts.

According to the statistically completed survey, it was observed that rural children in Gansu engage in significantly more activities on weekends compared to weekdays. They also exhibit a greater diversity in their choice of locations and activities [22]. Analyzing the daily activity hours of rural children in Gansu, a strong pattern emerges with peak activity hours occurring from 7:50–11:35 and from 14:00–17:35 on weekdays. While there are variations in daily activity hours during holidays compared to weekdays, there is still an overall regularity, except for an additional hour of homework from 17:00–18:00 during the holidays that overlaps with class hours on weekdays.

Rural children's daily routines have a more pronounced pattern, which is influenced by the time they go to and from school, and the time they eat. As can be seen in Figure 7, during the week, starting from 6:00 children get up to wash, eat, and go to school, and at 7:00 classes start one after another until 11:35; between the end of classes at noon and 14:00, the activities of the students in descending order of percentage are eating, sleeping, and doing homework; between 14:00 and 17:35 is the afternoon class time, and the time for doing homework will continue one after another after the end of classes until 21:35, while only a few children will play until about 22:00, and most of them have already gone to sleep. After class, homework will continue until 21:35, while only a few children will play until about 22:00, and most of the children have already gone to sleep. According to the information in Figure 8, it can be summarized that children's daily activity spaces during the week are

concentrated in schools, the county, on the way to and from school, in friends' houses, on the streets and at home, and only a small period of play time after dinner is in the square, and the play time is mainly concentrated between 18:00 and 21:00. As shown in Figure 8, television as an important influence on rural children's understanding of the world during their growth process, also occupies most of the time in rural children's daily activities in Gansu, which is mainly concentrated in the period between 18:00 and 23:00, up to five hours, which is extremely unfavorable to the development of children's eyesight. Rural children's daily activities are influenced by their daily school hours, and there is no extra tuition after school or on weekends, so their daily activities are relatively homogenous and their work and rest schedules are relatively regular.

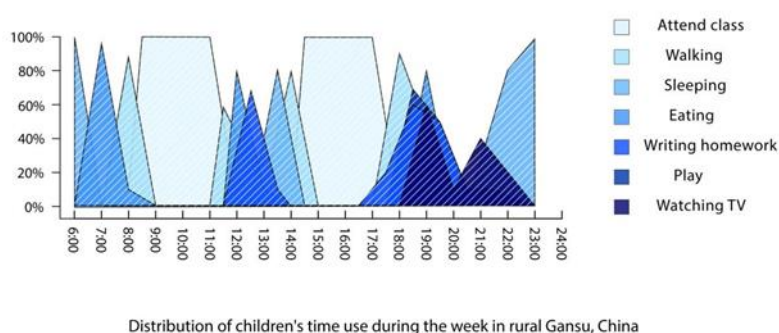


Figure 7. Distribution of children's time use during the week in rural Gansu, China. (Image data was obtained from the author's questionnaire).

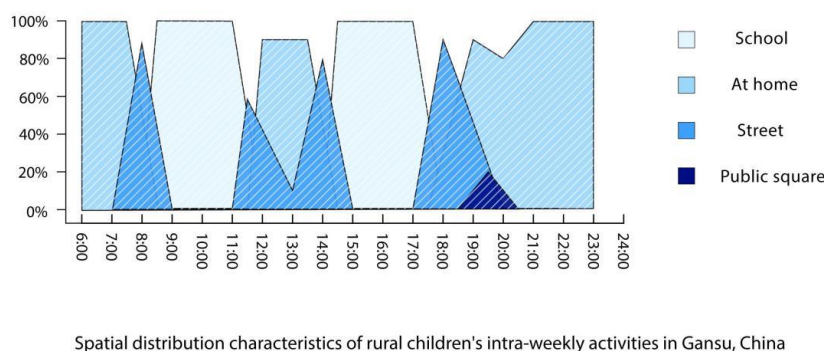


Figure 8. Spatial distribution characteristics of rural children's intra-weekly activities in Gansu, China. (Image data was obtained from the author's questionnaire).

As can be seen from Figure 9, the activities of Gansu rural children on weekends are influenced by their daily work and rest schedules, and the time for homework basically overlaps with the school hours during the week, but they are significantly richer in the types of activities than during the week. The weekend activities of Gansu rural children and teenagers are mainly concentrated in the morning from 8:00–11:00, in the afternoon from 15:00–17:00, and after 18:00, and they mainly focus on outdoor

activities, including those in the vicinity of their own homes, squares in the villages and towns, streets, and forests and fields. The square, as the place where rural children in Gansu spend most of their weekend time and most frequently, is active from 7:00–19:00, with the largest number of children active from 9:00–12:00, from 14:00–17:00, and after 19:00 respectively. Activity near the home was also longer, with children active from 10:00–16:00 and from 17:00–20:00.

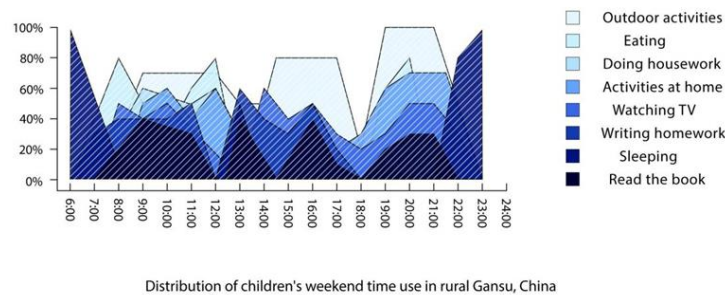


Figure 9. Distribution of children's weekend time use in rural Gansu, China. (Image data was obtained from the author's questionnaire).

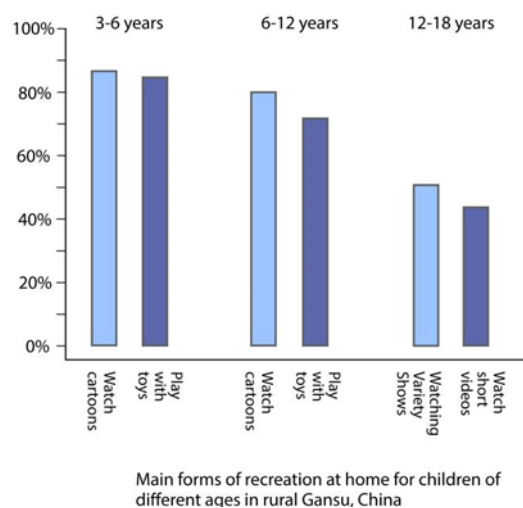
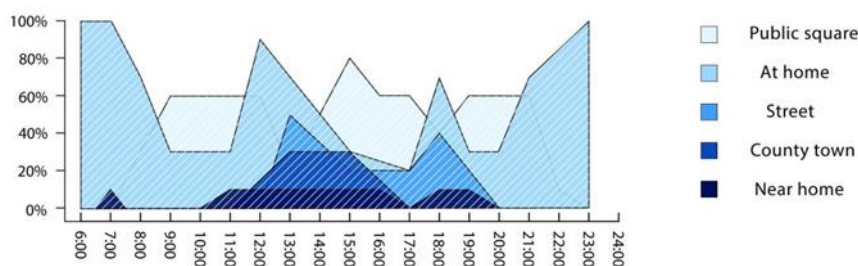


Figure 10. Main forms of recreation at home for children of different ages in rural Gansu, China. (Image data was obtained from the author's questionnaire).

According to the analysis of the daily activity time of Gansu rural children during the week and on weekends, it can be seen that the daily activities of Gansu rural children are relatively limited. During the week, the average activity time is only 90 minutes from 18:35–20:00 in the evening, in addition to class time. Watching TV at home is the main leisure and recreational activity for Gansu rural children (see Figure 10). From Figure 11, it is evident that children in rural Gansu engage in a wider range of activities on weekends and have more varied places to do them. Children whose parents are at home have a greater variety of activities and often venture to more distant locations. On the other hand, left-behind children still primarily watch TV at home, which can lead to psychological problems such as isolation, low self-esteem, lack of self-confidence, poorer social skills, and limited

communication with both peers and parents. In terms of gender differences, boys have a broader range of weekend activities, frequently visiting squares, streets, woods, friends' homes, and areas near their own homes. Girls, on the other hand, engage in a wider range of activities compared to boys, with household chores such as cooking and cleaning [23,24].



Spatial distribution characteristics of children's weekend activities in rural Gansu, China

Figure 11. Spatial distribution characteristics of children's weekend activities in rural Gansu, China. (Image data was obtained from the author's questionnaire).

3. Results and discussion

Through the analysis of the characteristics and types of rural children's activities in Gansu, China, it is found that the main sites for outdoor activities of rural children in Gansu include squares, streets, the periphery of courtyards, etc. In this regard, the five design principles of safety, fun, comfort, accessibility, and guidance are proposed for the design of outdoor activity spaces for rural children.

3.1. Problems of activity space in villages and towns in Gansu province

First of all, the spatial design of squares or streets should take into consideration the physiological structure of children, as rural outdoor children's activity spaces mainly cater to children. Apart from the spatial scale, enclosure facilities should also be designed with dimensions suitable for children, including their form and height, ensuring that children can comfortably use them. Second, since children are still in the stage of physical and psychological growth and have poor safety awareness, they are prone to accidents while playing. Therefore, the design of outdoor children's activity spaces should prioritize safety. These spaces should be located away from busy streets, highways, and rivers. Natural soft materials should be used for play equipment, ensuring their quality and firm installation. Protective ground surfaces such as lawns, sand, dirt, or plastic mats should be installed beneath the facilities. For ground pavement, choose flat, wear-resistant, non-toxic materials and ensure proper anti-slip treatment to maintain both aesthetics and safety. The materials used for the facilities should be safe and environmentally friendly, and regular maintenance should be conducted to ensure their upkeep. To ensure the safety of children while playing in these spaces, it is important to avoid installing equipment that may be drastic or have a significant impact. The paving scale should also vary depending on the space's size, with smaller private spaces having reduced paving scales and using small-scale paving to form larger patterns that enhance children's cognitive awareness and provide a sense of security.

Exaggerated paving scales can be used for more spacious, dynamic activity areas to give children a strong sense of vision [25]. When constructing buildings and vignette facilities, natural materials should be used as much as possible, and treatments should be de-emphasized. In the selection of plant species, non-toxic and harmless plants that do not attract bees or other insects that pose a safety hazard should be chosen [26]. Apart from standard squares and streets, temporary activity sites constructed based on the type of children's activities may also emerge and disappear over time, such as streets, woods, village entrances, under trees, fields, etc. These spaces should be designed with safety in mind and enclosed using structures and plants [27].

3.2. Interesting outdoor spaces for rural children

Due to the singularity of the daily life of children in rural Gansu, the design of activity venues for children in rural Gansu should fully take into account the actual situation of rural children and should realize the diversity of functions of the venues as much as possible. From the perspective of horizontal space, attention should be paid to the division of points, lines, surfaces, and spatial layout of the space. As far as possible to meet the needs of rural children of different ages, at the same time, each space should be related to each other, and the layout of each space should be changed to form activity space, transition space, and rest space. From the vertical space, the vertical spatial sequence is enriched through the orderly changes of ground paving and terrain undulation [28]. As well as visual guides to guide children, play facilities, vignettes, and other devices are used as the medium for children's interaction and communication, and signs that impress children are formed in each space to attract them to go and play. To stimulate the adventurous spirit of children in the countryside and enhance their physical fitness, a vivid, flexible, and change-rich spatial pattern, and form can be created through the undulating changes in the terrain, such as changes in slope, the increase in the number of steps, the increase in the number of slopes, etc., which is conducive to the children's better perception of their surroundings, and to enhance their communication and interaction with the venue [29]. In addition, enclosure facilities can be used to separate small adjacent spaces and also serve as sitting or play facilities, thereby increasing children's opportunities for communication and play. When selecting plants for the activity venue in Gansu, which is located in Northwest China, it is important to choose plants that can adapt to the natural environment. It is also beneficial to incorporate a variety of colors, scents, and plant species to create a natural environment with varying heights and rich colors. This will provide children with more opportunities to engage and interact with nature [30].

3.3. The comfort of outdoor spaces for children in rural areas

Because Gansu is located in the northwestern region of China with a colder climate, natural factors play an important role in children's outdoor activities. These factors directly affect the comfort and perception of rural children in using outdoor activity areas. Sunlight exposure is a key factor that affects the openness of the space. Areas with better sunlight are often loved by children. To allow children to enjoy the sunshine without getting sunburned and to provide them with psychological pleasure, it is necessary to create a good sunlight environment through the reasonable combination of plants. Second, it is necessary to flexibly organize various spaces. For example, small spaces for children's play and communication should have sufficient sunlight exposure, while quiet areas for rest

and conversation should have appropriate shade. By considering the needs of children and parents in using the space, we can improve its accessibility and enhance the interaction between people and the space. A space with too much wind is unfavorable for children's play activities, so the prerequisite for ensuring the comfort of the space is to reasonably control the size of the wind, and the control of the wind is also a prerequisite for children to play more easily. Control of the wind can be carried out through the building design, terrain arrangement, high-density planting, and other methods. For example, using changes in terrain undulation to create a closed or semi-enclosed activity space for children, and planting tall trees in the direction of the dominant wind to form a natural windbreak barrier. This allows children to play happily in the space and strengthens their interaction with the venue. Noise can also have a significant impact on children, and psychologically it is more likely to cause them stress. In outdoor children's spaces, plantings and noise barriers, such as landscape walls, are often used to control noise, enhance comfort, and make children happy to stay and play in the space.

In addition to natural factors such as sunlight, wind, and noise, human factors in design are equally important in influencing the comfort of rural children's activity venues. To ensure that rural children in Gansu feel safe, comfortable, and cared for, and to enhance their motivation and communication with the spatial environment and their peers, it is necessary to design a variety of behavioral and activity spaces that are suitable for rural children in Gansu built on their psychological and behavioral characteristics. The D/H value, determined by the horizontal distance of spatial demarcation and the height of enclosing demarcation, has an impact on children's comfortable visual and psychological experience in outdoor activity venues. Therefore, for open or semi-open spaces in outdoor children's activity areas, the D/H value should be controlled between 1–3. This will make children feel comfortable and safe when playing, while also allowing them to appreciate the surrounding environment. For relatively private spaces, such as rest areas, and quiet play areas, privacy can be ensured by blocking the line of sight. The height of the blocking should be determined based on the scale of the children themselves. Controlling the D/H value between 0.5–1 is more appropriate for shading in these spaces. This will meet the multifaceted interaction needs of children and make the space more suitable for their use [31] (e.g., Table 2). Facilities in the venue should also be designed with considerations for children's ergonomics, as well as behavioral and psychological characteristics. For example, play facilities, rest facilities, sanitary facilities, etc., should not be made of materials that are too hard. It is best to use materials that have a soft and comfortable touch to enhance children's comfort and psychological well-being. When it comes to color coordination, bright colors should be chosen to stimulate children's brain development. However, it is important to pay attention to the balance between warm and cool colors. Using too many warm colors can cause fatigue and sleepiness, so they should not be used extensively. Finally, barrier-free design should also be taken into account to accommodate the needs of special rural children and provide them with a healthy and joyful environment for growth. This reflects care for them and increases their enthusiasm to participate in games, allowing them to have the same experience as other children in terms of gameplay and interaction. It also ensures that they have a positive outdoor playing experience.

Table 2. The influence of the horizontal distance of the spatial divisions and the height of the enclosing divisions on the psychological perception of children.

D/H Ratio	Children's psychological feelings
< 1	The space is cramped, the children are close to their surroundings and it is a private space, and the smaller the ratio the more depressing the space feels.
= 1	Space proportioned to make children feel comfortable and private.
= 2	The privacy is reduced and is the largest scale of the enclosed space, which is semi-enclosed.
> 2	Poorly enclosed, which can make children feel distant and is an open space.

3.4. Accessibility of outdoor spaces for children in rural areas

According to the survey of rural children in Zhangye City, Gansu Province, it can be seen that the distance of the activity site from home is also an important factor influencing rural outdoor children to go to the activity, influenced by the daily meal time and whether they are left-behind children or not. Typically, the activity area of rural children in Gansu is centered on their homes, with a radius of approximately 15 minutes. Therefore, it is necessary to rationally arrange the location of the activity site in the village, as well as create convenient transportation routes to facilitate the arrival of children and parents. This will help stimulate children's motivation to participate in activities and provide more opportunities for left-behind children to engage in socialization and various activities [32,33]. It is vital to ensure that the routes within the site are smooth and form closed loops of activity routes to avoid breaks in the road. If there is a need for multiple functional routes to be present, they need to be separated from each other to avoid the adjacency of travel lanes and children's activity routes, thereby preventing safety issues.

3.5. Guided outdoor spaces for children in rural areas

Not only do children want to play and learn outdoors, but it is also extremely important for them to communicate with their peers and foster the emotional connection between parents and children [34,35]. Moreover, according to a survey of rural children in Gansu, many children's entertainment is based on watching TV at home, which not only lacks the opportunity to go out and communicate with peers but also causes serious vision problems that parents are worried about. Most parents said that in addition to the time taken up by homework, their children's time for outdoor play was greatly reduced compared to their own childhood. Therefore, in the design of Gansu rural children's outdoor activity venues, everything from the ground pavement to the visual guide should play an attractive role in attracting and guiding children. For example, the entrance of the activity site should feature obvious and impressive structures, creating a clear image in children's minds so that they can easily describe the location and find their way back. The ground pavement can have special features that extend from the venue to help guide children in the right direction. Additionally, plants with special fragrances and brilliant colors can be planted at the entrance and surrounding areas of the activity venue to provide

cues to children through their visual and olfactory [36]. Second, the role of inducing rural children to learn is also essential. Childhood is a stage of rapid growth in which children are full of curiosity about the world, and in the rural areas of Gansu, which is located in the northwestern part of China, the reception of news from the world is extremely slow, and the way for children to acquire knowledge is also relatively single. Adding the opportunity to learn knowledge and understand local culture into the design of rural activity venues not only helps rural children develop learning habits but more importantly, can understand local culture from childhood and enhance their sense of identity with local culture. Finally, the design of activity venues provides rural children with space to socialize and interact with their peers and parents, thus promoting parent-child relationships and enhancement of rural children's spirit of cooperation and social skills.

Fundamentally speaking, a good design for rural children's activity venues needs to be suitable for rural children's daily activity habits and to facilitate children's healthy physical and mental growth. According to the five design principles proposed in the previous analysis of the characteristics of rural children's activities in Gansu Province, the development of children's natural and social attributes should be satisfied simultaneously. The interesting nature of the activity site attracts children, satisfying their innate love for nature and promoting their physical health development. The guided nature of the design leaves a deep impression on children, guiding their direction, facilitating learning, and encouraging socialization, particularly for left-behind children to foster parent-child relationships. The accessibility of the venue allows children to conveniently and quickly arrive, providing a rich and diverse range of activities, especially for children whose parents are not present. This accessibility ensures a convenient and quick access to the venue, offering left-behind children a varied and engaging activity space. Additionally, ensuring safety and comfort enables children to spend more time at the venue, reducing their TV viewing time at home and addressing the issue of nearsightedness among children.

4. Conclusion

In the process of modernization and the transformation of rural society, the healthy growth of rural children is influenced by the daily life environment of the family, the school, and the rural environment. Children grow up in this environment, and since a person's childhood consists of memories of his or her daily life as a child, a child's healthy development is inextricably linked to his or her childhood. In addition, children are also influenced by indirect factors such as peers and parents' work environment, which ultimately leads to the formation of children's diverse personalities. Therefore, in the design of rural children's activity spaces, the role of rural activity spaces and facilities on children's healthy growth should be fully considered, so as to create a good living environment for the physical and mental healthy growth of rural children.

First, the differences in development between Northwest China and coastal cities, along with the uneven distribution of social resources, have led to a chronic lack of material and spiritual resources for rural children. According to the latest data released by the National Bureau of Statistics comparing Guangdong Province and Gansu Province in 2022, the forest coverage rate in Guangdong Province in 2022 is as high as 53.5%, while the forest coverage rate in Gansu Province is only 11.3%; Similarly, Guangdong Province has 4,969 parks compared to Gansu Province's mere 225 parks. Moreover, the expenditure on general public services in Guangdong Province in 2022 reached 177,374,000 yuan, whereas Gansu Province's general public service expenditure was only 39,734,000 yuan. As a

consequence, research on rural children in Gansu, China, has revealed that rural children in remote areas of Gansu lacked access to the most basic urban public cultural resources. These resources remain virtually out of reach for rural children, resulting in limited opportunities for their social and cultural development. Furthermore, the research findings indicate that these children often exhibit behaviors such as low self-esteem, shyness, and isolation as they grow up, which are frequently overlooked. They tend to withdraw themselves and hesitate to communicate with their peers, teachers, and parents. In addition, they often blame themselves for any wrongdoing and may even feel remorseful for their parents' upbringing, leading to a strong sense of helplessness. It is crucial for society to sympathize with and support these socially withdrawn rural children, creating a safe space where they can open up and fulfill their spiritual needs.

Second, promoting children's development in various aspects includes encouraging them to participate in outdoor sports, which can help them build endurance, flexibility, and balance, enhance their physical fitness, strengthen their physique, and boost their immunity. Adventure-type games, on the other hand, can sharpen children's willpower, cultivate their sense of adventure, and develop their resilience in the face of difficulties. Role-playing games can also benefit children's language development by encouraging them to interact with peers and exercise their social skills. Moreover, role-playing allows children to put themselves in the shoes of adults, promoting their ability to empathize with others. Games involving building blocks, snowmen, and sand can enhance children's creativity, imagination, and hands-on skills. Finally, intellectual games with rules are ideal for older children, as they promote the development of critical thinking, reasoning, and judgment skills.

Finally, in terms of promoting children's interactions with people, the interaction behaviors generated when children contact the environment during activities can be divided into parent-child interactions, peer-to-peer interactions, and interaction behaviors with plants and animals [37]. Parent-child interaction behavior mainly refers to the communication and interaction between children and their parents, rural children due to various reasons such as parents going out to work, resulting in a lack of emotional communication between parents and children, which has an impact on the healthy development of children's physical and mental health. Interaction behavior with peers, on the other hand, refers to activities such as learning and playing with children of similar ages, which affects the development of children's social skills. Children have an innate desire to connect with nature, and interaction with plants will enable children to explore the natural world through their senses. Driven by curiosity, children can exercise their cognitive and perceptual abilities as they engage with the environment. Similarly, interacting with animals can cultivate children's sense of love and responsibility, contributing to their all-round development.

Therefore, the design of rural outdoor activity areas plays an important role in the physical and mental health development of rural children, mainly in terms of their physiological and psychological elements. First, in terms of physiological elements, children's running, jumping, and other behaviors in outdoor activities effectively promote the development of physical fitness; at the same time, through the communication of language and partners, it helps children to cultivate social skills in the process of playing with peers. Second, in terms of psychological elements, children's hands-on ability, imagination, creativity, empathy, reasoning, judgment, and other aspects of thinking will be enhanced, while high-quality outdoor activities can also meet the needs of children's physical and mental development. Environmental factors affect children's growth at any time. A reasonably designed outdoor activity site will promote children's healthy growth, but if the outdoor activity site is poorly

designed, it will hinder children's healthy growth. Therefore, the influence of children's behavioral psychology and environmental factors should be fully considered when designing children's outdoor activities.

Children's physical and mental health problems are becoming more and more prominent, and as a special group, their growth deserves more attention from society. First, local governments should prioritize the needs of children's activities by increasing relevant expenditures and constructing more outdoor activity spaces tailored to children. Second, the design of children's outdoor public activity space in rural areas should not only create a favorable outdoor environment but also consider the unique characteristics of children's activities, taking into account the varying behavioral traits of different age groups and children from diverse family backgrounds. Finally, the design of children's public activity spaces in rural areas should also promote children's interaction behavior through interesting spatial forms, which is beneficial to children's healthy growth. Through an examination of children's activity patterns, parental concerns, and the numerous benefits associated with outdoor activity spaces, this paper proposes essential factors that warrant attention in the design of rural children's outdoor activity spaces, aiming to provide feasible solutions for the establishment of such spaces in rural areas.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Data availability

The data used to support the findings of this study are included within the article.

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Conflict of interest

There is no conflict of interest in this study.

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