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Outdoor Physical Activity Patterns and Perceived Participation Factors Among Children Aged 9 to 11 Years in a High-Density Beijing Community

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ABSTRACT

Outdoor physical activity provides opportunities for movement and social interaction during middle childhood, yet neighbourhood access alone may not capture how children participate. This study described perceived outdoor space availability, weekly activity frequency, session duration, and perceived participation factors among children aged 9–11 years in Tiantong Zhongyuan Community 1, Beijing, China. A descriptive cross-sectional questionnaire survey was conducted through a local primary school. Of 152 questionnaires distributed, 149 were included after quality screening. Three single-choice items assessed space availability and activity patterns, and one multiple-choice item assessed six perceived participation factors. Frequencies and percentages were calculated, with multiple-response percentages expressed relative to both participants and total selections. Nearby outdoor activity spaces were reported by 103 children (69.1%). The most common weekly frequency was 2–4 sessions ($n = 69$, 46.3%), followed by 5–7 sessions ($n = 46$, 30.9%). The most frequently reported session duration was 1–2 hours ($n = 89$, 59.7%). Friends to play with ($n = 105$, 70.5%) and ease of access ($n = 88$, 59.1%) were the most commonly selected participation factors; parental supervision was selected least often ($n = 50$, 33.6%). These findings identify prominent frequency and duration categories and highlight the salience of peer companionship and accessible outdoor spaces in children's perceptions. Because activity intensity and relationships between variables were not assessed, the results do not establish compliance with physical activity guidelines or causal determinants of participation. Accessible neighbourhood spaces that support shared play merit consideration in community planning and further evaluation using objective activity measures.

INTRODUCTION

Physical activity is important to children's health and development. The World Health Organization recommends that children and adolescents aged 5–17 years undertake an average of at least 60 minutes per day of predominantly aerobic moderate-to-vigorous physical activity (MVPA) across the week^[1]. Outdoor activity offers one setting in which children can accumulate movement, although time spent outside and time spent in MVPA are distinct measures. Childhood obesity is associated with a range of physical and psychosocial health concerns^[2], while unstructured outdoor play has developmental value beyond exercise alone^[3]. Understanding children's outdoor participation therefore requires attention to both activity behaviour and the everyday settings in which it occurs.

Urban environments can shape children's opportunities to use outdoor spaces. Traffic conditions, parental restrictions, and accessibility may influence independent mobility and access to streets and public places^[4]. In dense residential communities, the presence of a nearby activity area may offer an opportunity for outdoor participation, but its presence does not establish whether children can reach it easily, find companions there, or use it regularly. Space availability, activity frequency, session duration, and perceived participation conditions capture complementary aspects of this relationship.

Middle childhood is a relevant period for examining these behaviours. Previous research has described reductions in outdoor time between early childhood and later childhood^[5], and longitudinal evidence indicates that declines in physical activity can begin before adolescence^[6]. Changes in activity and sedentary behaviour during and after the pandemic have also been discussed for school-age children, including those aged 8–11 years^[7]. Such patterns occur alongside changes in children's routines and lifestyles^[8]. These studies support closer attention to children aged 9–11 years, but they do not imply that all children in this age range share the same activity trajectory.

Developmental changes may also affect what children value in outdoor participation. Middle childhood involves physical, cognitive, and social development^[9]. Piaget^[10] described the emergence of concrete operational thinking, while more recent work has examined children's developing social understanding and friendships^[11]. Physical activity can provide opportunities to interact with peers, and activity patterns may reflect the social context in which play occurs. Prochnow^[12] examined peer-related activity patterns, while Caceffo^[13] addressed children's experiences and the context of participation. Together, these perspectives suggest that children's own

accounts of participation conditions can complement measures of activity volume.

The Chinese urban context warrants attention. Huang^[14] reported that approximately 5% of Chinese adolescents in their study achieved at least 60 minutes of MVPA on every day of the preceding week. This measure should be distinguished from the WHO recommendation expressed as a daily average across the week, and findings for adolescents should not be treated as estimates for younger children. Liu^[15] also examined obesity and physical activity among children aged 6–18 years in Beijing, drawing attention to the 9–11-year age group. These studies provide context for examining outdoor participation in Beijing, without establishing the activity profile of any individual residential community.

Existing research addresses activity levels, environmental conditions, and social influences, but a focused community description can bring these dimensions together for a specific developmental stage. The present study examined children aged 9–11 years living in Tiantong Zhongyuan Community 1, a dense residential community in Beijing. Its aim was to characterise outdoor physical activity through four indicators: perceived availability of nearby outdoor activity spaces, weekly frequency, session duration, and perceived participation factors. The research questions were whether children perceived nearby spaces as available, which frequency and duration categories were most common, and which participation factors children selected most frequently. The study was descriptive; it did not test environmental effects or associations between individual characteristics and activity outcomes.

MATERIALS AND METHODS

Study design and setting: A descriptive cross-sectional questionnaire survey was conducted in Tiantong Zhongyuan Community 1, located in the Tiantongyuan area of Changping District, Beijing, China. Tiantongyuan is a large residential development with a high concentration of housing and residents. Planning and census sources report populations of 142,707 for Tiantongyuan North Subdistrict and 116,529 for Tiantongyuan South Subdistrict, giving a combined population of 259,236^[16, 17].

The selected community contains approximately 65 residential buildings and a local public primary school. Questionnaire distribution and collection took place through Tsinghua University Primary School (Chang Ping School). This school provided a practical recruitment setting for children in the target age range who lived in the community. The sampling frame was defined by school access and residential eligibility; it was not a city-wide sample.

Participants and sample size planning: Eligible participants were aged 9-11 years, corresponding approximately to Grades 3–5, and lived in Tiantong Zhongyuan Community 1. Eligibility required the ability to understand and complete the questionnaire, a health condition permitting usual physical activity, parental or guardian informed consent, and the child's voluntary agreement to participate. Children outside the age or residential criteria, those without parental or guardian consent, and those unable to complete the questionnaire were excluded. Participation was voluntary, and children retained the right to withdraw.

The target population was estimated for sample size planning using district-level educational and population statistics. The Changping Statistical Yearbook 2024 reported 72,133 primary school students and a permanent resident population of 2.272 million^[18], giving a primary school student proportion of approximately 3.17%. Assuming that Grades 3–5 represented approximately half of primary school enrolment, children in the target grades were estimated to comprise approximately 1.585% of residents. Applying this proportion to an estimated community population of 12,000 yielded a target population of approximately 190 children. This calculation was a planning approximation rather than an enumeration of eligible residents.

The sample size formula attributed to Yamane^[19] was used: $n = N / (1 + N e^2)$, where n is the planned sample size, N is the estimated target population, and e is the precision parameter. With $N = 190$ and $e = 0.05$, the calculation yielded 128.8, rounded up to 129 participants. The final analytic sample of 149 exceeded this planning figure. However, exceeding the planned size does not independently establish representativeness or a guaranteed margin of error, particularly because a probability sampling procedure was not documented.

Questionnaire and measures: Questionnaires were used to obtain structured quantitative information, consistent with their application in survey research^[20]. The activity section contained four items. Three single-choice items assessed perceived availability of nearby outdoor activity areas, weekly outdoor physical activity frequency, and duration of each activity session. The fourth item allowed multiple selections from six perceived participation factors.

Space availability had two response categories: yes and no. Weekly frequency categories were once per week, 2–4 times per week, 5–7 times per week, and no playing outside. Session duration categories were less than 30 minutes, 1–2 hours, 3–4 hours, and over 5 hours. The six multiple-response options were ease of access, friends to play with, physical activity

facilities, natural elements, parental supervision, and an area for resting.

These measures captured children's perceptions and reported participation categories. Space availability did not measure distance, area, quality, safety, or actual use of a particular site. Frequency and duration did not measure activity intensity or distinguish active movement from other time within an outdoor session. The multiple-response item recorded whether children selected each factor; it did not ask them to rank factors or estimate the magnitude or direction of an effect.

Data collection and ethical considerations: School teachers distributed and collected the questionnaires. The recruitment criteria required parental or guardian informed consent and children's voluntary agreement. The research protocol also specified that image and video materials, if recorded, would be restricted to research documentation or analysis and would not be publicly disseminated without additional authorisation. No identifiable images or video data are presented in this article.

A total of 152 questionnaires were distributed. Questionnaires were screened for completeness and compliance with response instructions. Three questionnaires were excluded as invalid, and 149 were retained for analysis. The available record does not separately identify the number returned before screening; accordingly, 149/152 is reported as the proportion of distributed questionnaires retained for analysis rather than as a verified response rate.

Data analysis: Frequency counts and percentages summarised the three single-choice items. Because these items used categorical responses rather than exact numerical measurements, means and standard deviations for weekly activity frequency and session duration were not calculated. Percentages were calculated using the analytic sample of 149 as the denominator and rounded to one decimal place.

For the multiple-response item, each option was treated as a separate selected or not-selected category. Two percentages were calculated: the percentage of participants selecting an option and the percentage of all selections represented by that option. The six reported option counts totalled 456 selections. The percentage of participants could therefore sum to more than 100%, whereas the distribution of selections summed to 100%, subject to rounding. No inferential tests, regression models, subgroup comparisons, or individual-level cross-tabulations were conducted. Relationships between space availability, frequency, duration, and perceived factors were not estimated.

RESULTS AND DISCUSSIONS

Analytic sample and perceived space availability: The analytic sample comprised 149 children aged 9–11 years. The proportion of distributed questionnaires retained was 98.0% (149/152). Table 1 presents the reported activity characteristics. Nearby outdoor activity spaces were perceived as available by 103 children (69.1%), whereas 46 children (30.9%) reported no such spaces. Thus, although a majority perceived an outdoor opportunity near home, almost one-third did not.

The majority response is broadly consistent with the prominence of neighbourhood spaces in children's everyday activities. Q. Fan^[21] reported that 58.83% of surveyed families considered outdoor activity spaces sufficient, while Zhou^[22] examined neighbourhood settings relevant to children's daily lives. These findings provide contextual comparisons, but perceived sufficiency reported by parents and perceived availability reported by children are different constructs. Differences in respondents, settings, and question wording prevent direct numerical comparison.

Availability should also be separated from accessibility and quality. A child may recognise that a space exists while experiencing difficulty reaching it or finding it suitable for play. Conversely, a negative availability response may reflect how the child interprets an activity space rather than an objectively documented absence. The present data identify perceptions of provision; they do not establish geographic coverage, environmental quality, or whether children with access participated more frequently. Those relationships require linked individual data and more detailed spatial measures.

Weekly frequency and session duration: The most common frequency category was 2–4 outdoor activity sessions per week, selected by 69 children (46.3%). A further 46 children (30.9%) selected 5–7 sessions per week, 27 (18.1%) selected once per week, and seven (4.7%) reported no playing outside. In total, 142 children (95.3%) reported some weekly outdoor activity, and 34 (22.8%) selected either once per week or no outdoor activity. These figures describe the prevalence of reported participation categories and do not quantify overall physical activity volume.

For session duration, 89 children (59.7%) selected 1–2 hours, 28 (18.8%) selected less than 30 minutes, 18 (12.1%) selected 3–4 hours, and 14 (9.4%) selected over 5 hours. The modal frequency and duration categories therefore describe an intermediate position within the questionnaire's response options. They should not be interpreted as a moderate-intensity activity classification. Because frequency and duration

were not cross-tabulated, the data also do not show how many individual children simultaneously reported 2–4 sessions per week and 1–2 hours per session.

Previous studies provide points of comparison. Shi (2017) examined outdoor activities among children aged 7–12 years in Wuhan, including participation patterns and duration. Rong-bin^[23] also reported duration categories among Chinese students, with 1–2 hours reported as a prominent category. Similarity in the most common category suggests a potentially useful line of comparison, but variation in age groups, recall periods, activity definitions, and duration thresholds limits any claim of equivalent behaviour across studies.

The concentration in the 2–4-session and 1–2-hour categories may be compatible with outdoor activity occurring alongside school and household routines. However, the survey did not measure homework, extracurricular schedules, screen use, family routines, or reasons for infrequent participation. It cannot demonstrate that these constraints produced the observed distribution. Children reporting little outdoor activity may undertake physical activity indoors, at school, or in organised settings that were not captured by this item.

Session duration requires particular caution. The options leave intervals unrepresented, including 30–59 minutes and durations between the longer categories. Furthermore, duration responses totalled 149 despite seven children reporting no playing outside. Without item-level records and the original instructions, it is unclear whether these children reported a typical session outside the weekly reference period, answered a hypothetical item, or followed a different interpretation. Long sessions may also include rest and social interaction rather than continuous exercise. These issues limit the precision and comparability of the duration estimates.

Accordingly, the findings cannot establish adherence to the WHO MVPA recommendation^[1]. They also cannot classify children as sufficiently active or inactive overall. Doing so would require measures of intensity, activity across settings, and an appropriate time reference. Objective measurement combined with a location or activity diary would help determine how reported outdoor time contributes to total movement

Perceived participation factors: Table 2 shows the distribution of selections for the six perceived factors. Friends to play with was selected most frequently ($n = 105, 70.5\%$), followed by ease of access ($n = 88, 59.1\%$). Resting areas ($n = 73, 49.0\%$), natural elements ($n = 71, 47.7\%$), and physical activity facilities ($n = 69, 46.3\%$)

Table 1: Reported outdoor activity characteristics

Measure	Response category	n	%
Space availability	Yes	103	69.1
	No	46	30.9
Weekly frequency	Once per week	27	18.1
	2–4 times per week	69	46.3
	5–7 times per week	46	30.9
	No playing outside	7	4.7
Session duration	Less than 30 minutes	28	18.8
	1–2 hours	89	59.7
	3–4 hours	18	12.1
	Over 5 hours	14	9.4

Note: N = 149. Percentages use all 149 participants as the denominator. Categories are retained as reported; duration responses require confirmation of skip logic.

Table 2 Multiple response distribution of perceived participation factors

Factor	Selections n	% of selections	% of participants
Ease of access	88	19.3	59.1
Friends to play with	105	23.0	70.5
Physical activity facilities	69	15.1	46.3
Natural elements	71	15.6	47.7
Parental supervision	50	11.0	33.6
Area for resting	73	16.0	49.0
Total selections	456	100.0	306.0

Note: N = 149 participants; 456 selections. Multiple selections were permitted. Participant percentages sum to more than 100%. Selection percentages may differ slightly from 100% when rounded.

received similar proportions of selections. Parental supervision was selected by 50 children (33.6%). Across the six options, participants made 456 selections, equivalent to approximately 3.1 selections per child.

These results indicate the relative frequency with which children identified the listed factors. They do not establish an ordered ranking of importance for each child, statistically significant differences between options, or the size of any association with participation. Because multiple selections were permitted, social and environmental considerations could coexist within the same child's responses. Their joint selection patterns were not available for analysis.

Peer companionship and accessible neighbourhood spaces: The frequent selection of friends suggests that peer companionship is salient in how children describe outdoor participation. This interpretation is compatible with literature on friendships in middle childhood^[11], peer-related physical activity^[12], and community play among school-age children^[24]. Social identity theory offers a broader perspective on group membership and shared experience^[25], but the present questionnaire did not measure social identity or test that theoretical mechanism.

Outdoor spaces may offer settings for shared games, informal encounters, and maintaining friendships. A space's appeal may therefore depend partly on whether familiar companions are available. This is a plausible interpretation of the high selection frequency for friends, rather than evidence that peer presence caused greater activity. The study did not

record group size, friendship networks, activity types, or the timing of peer encounters. Nor did it distinguish whether friends encouraged activity or whether children who already enjoyed activity were more likely to identify companions as relevant.

Ease of access was the second most frequently selected option. Nearby spaces may reduce travel demands and make short opportunities for play easier to accommodate. Mobility and safety concerns discussed by Riazi provide context for this interpretation. However, the survey did not measure travel time, route conditions, independent mobility, or perceived safety. The result therefore supports accessibility as a perceived consideration, without demonstrating a distance threshold or an effect on activity frequency.

Together, the peer and access responses suggest that neighbourhood planning should consider whether children can reach places where shared play is possible. Design proposals might include connected pedestrian routes and flexible spaces for informal group activity. These are implications for future planning and evaluation, rather than interventions whose effectiveness has been established by this survey.

Facilities natural elements resting areas and parental supervision: Physical activity facilities, natural elements, and resting areas were selected by approximately half of participants. Their lower selection frequencies relative to friends and access do not demonstrate weaker causal effects or merely

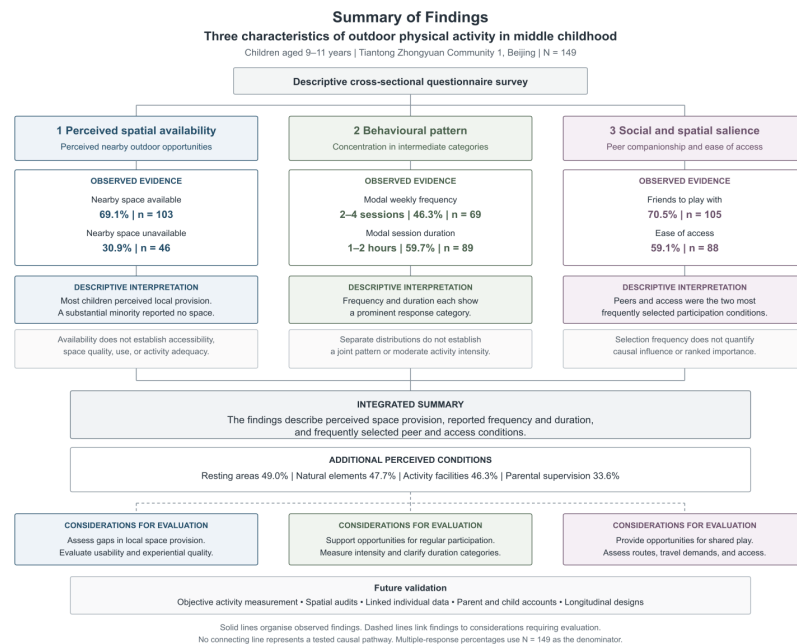


Figure 1: Descriptive framework summarising three characteristics of outdoor physical activity in middle childhood.

Note: N = 149 children aged 9–11 years. Weekly frequency and session duration are separate distributions. Participation-factor percentages use the number of participants as the denominator, with multiple selections permitted. Solid lines organise the findings; dashed lines link the synthesis to considerations for further evaluation. Neither line type represents a tested causal pathway.

indirect roles. Zhang^[26] examined environmental conditions relevant to children's activity, and Fan^[21] linked outdoor provision with participation in a parental survey. Shi and Mani & Woolley^[24,27] also addressed children's experiences and preferences concerning outdoor environments. The present results are compatible with environmental features mattering to children, but they cannot resolve how specific features influence use, duration, or satisfaction.

Natural elements and resting areas may support comfort and the broader experience of being outdoors. Equipment may support particular games or movement opportunities. The questionnaire did not assess the quantity, condition, diversity, or actual use of these features. It is therefore inappropriate to infer that improving one feature would produce a specific increase in physical activity or to treat the small descriptive differences between these options as an established priority order.

Parental supervision had the lowest selection frequency, but one-third of children still selected it. A child-reported participation item may capture different considerations from parental reports of permission, accompaniment, or safety restrictions. Shi^[24] discussed parental supervision and safety in children's outdoor activity, providing a reason to consider both perspectives. The present findings cannot show that

parental influence is unimportant, that children resist supervision, or that boys and girls perceive it similarly. These explanations would require measures of parental practices, children's autonomy, and relevant subgroup analyses.

Strengths limitations and future research: The study provides a focused description of children aged 9–11 years within one dense Beijing residential community. It brings together perceived space availability, reported participation categories, and multiple perceived factors using a consistent analytic sample. Reporting both participant-based and selection-based percentages makes the multiple-response results interpretable and avoids treating them as mutually exclusive categories.

Several limitations constrain inference. First, the cross-sectional descriptive design does not establish temporal or causal relationships. Aggregate distributions do not demonstrate associations between environmental perceptions and activity patterns. Second, recruitment through a single school may omit eligible children attending other schools or those absent during collection. The sample size planning used a population estimate derived from district statistics and assumptions about grade composition; it does not substitute for a complete sampling frame. Findings should therefore be interpreted within the

participating community rather than generalised to all Beijing or Chinese children.

Third, self-reported responses may be influenced by recall, interpretation, and social desirability. Teacher-mediated administration could also influence children's responses, depending on the collection procedure. Questionnaire validity, reliability, and the recall period require documentation. Fourth, the categorical frequency and duration measures do not capture exact exposure, activity intensity, or total daily physical activity. Gaps in duration categories and the absence of documented skip logic further limit interpretation.

Fifth, perceived availability was not verified through environmental audits or geographic analysis. The factor item was restricted to six options and did not measure their direction, relative importance, or strength of influence. Relevant considerations such as weather, academic demands, traffic, family resources, or other activity settings were not assessed in the reported section. Sixth, age-specific, sex-specific, and other subgroup distributions were unavailable, and no subgroup conclusions can be drawn. Finally, survey dates and ethical review details must be documented to permit assessment of seasonality, context, and research governance.

Future research should use inclusive, clearly bounded response options and explicit skip instructions for children reporting no outdoor activity. Linking individual activity responses with measured distance, route conditions, and space quality would allow associations to be examined. Accelerometry and activity diaries could clarify the contribution of outdoor sessions to MVPA, while parent and child accounts could distinguish permission and safety conditions from children's preferences. Longitudinal or intervention designs would be needed to evaluate whether changes in accessibility, peer opportunities, or environmental provision led to sustained changes in participation.

Summary of findings: The findings can be synthesised into three complementary characteristics of outdoor physical activity in middle childhood: perceived spatial availability, concentration of reported frequency and duration in intermediate response categories, and the salience of peer companionship and ease of access (Figure 1). Most children reported nearby outdoor activity spaces (69.1%). The most common weekly frequency was 2–4 sessions (46.3%), while the most common session duration was 1–2 hours (59.7%); these describe separate distributions rather than a confirmed joint activity pattern. Friends to play with (70.5%) and ease of access (59.1%) were the most frequently selected participation factors. Together, these findings provide a descriptive basis for considering local space provision, opportunities for regular activity, and shared play in neighbourhood

planning. Figure 1 distinguishes the observed evidence and its interpretation from planning considerations and future validation needs. It does not represent tested causal pathways, and neither the reported duration nor the frequency establishes activity intensity or compliance with MVPA recommendations.

CONCLUSION

Among 149 children aged 9–11 years surveyed in Tiantong Zhongyuan Community 1, Beijing, 69.1% perceived nearby outdoor activity spaces as available. The most common reported weekly frequency was 2–4 sessions, and the most common session duration was 1–2 hours. Friends to play with and ease of access were the most frequently selected perceived participation factors. These findings offer a community-specific description of outdoor activity and highlight social opportunities and access as salient elements of children's reported experience.

The study does not establish causal determinants, subgroup differences, or compliance with MVPA guidelines. Its practical contribution is to identify considerations for subsequent assessment: whether neighbourhood spaces are reachable, whether they support shared play, and how reported outdoor participation translates into objectively measured activity. More detailed measurement and broader recruitment are needed before intervention effectiveness or population-level conclusions can be established.

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