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Co-Creating Questionnaire to Assess Exposure of Adolescents to Green Spaces

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Glossary of Acronyms

ADHD	Attention Deficit Hyperactive Disorder
AI	Artificial Intelligence
ART	Attention Restoration Therapy
CVD	Cardio Vascular Diseases
dB	Decibel
EPS	Éducation Physique et Sportive
IRSET	Institut de recherche en santé, environnement et travail
NDVI	Normalized Difference Vegetation Index
PM	Particulate Matter
SGS	Scania Green Score
UHI	Urban Heat Island
YLD	Years Lived with Disability
ChatGPT	Chat Generative Pre-Trained Transformer

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Abstract

Background: Adolescents are particularly sensitive to environmental stressors, making their interaction with green spaces crucial for their physical, mental, and social development. While existing research highlights the health benefits of green space exposure, there is limited understanding of how adolescents access, use, and perceive these environments.

Objective: To co-create an adolescent-friendly questionnaire that assesses the exposure of public green spaces for French adolescents in three domains: usage, services and perception.

Methods: An exploratory literature review informed a provisional questionnaire framework. Participatory knowledge generation combined (i) a co-creation workshop with three male adolescents (12 and 14 y) in Rennes, (ii) a focus group discussion with 11 health experts, and (iii) comparative analysis with a baseline questionnaire generated by ChatGPT. Inputs were iteratively synthesised to refine content, wording, and structure of the questionnaire.

Results: The workshop with the adolescents showed that they engage with green spaces both intentionally and incidentally, especially when it is part of their daily trajectories. They consider schoolyards and informal green areas as significant and categorised eight types of green spaces, based on their functionality. Temporal variations in access to green space use (e.g., weekday vs. weekend, school period vs. holiday) emerged as a critical factor. The expert focus group further emphasized the importance of capturing temporal variability and functional definitions of green space. Private-garden was identified as a potential confounder and was subsequently addressed in another section of the questionnaire. Experts also stressed the need to assess both positive sensory cues along with negative sensory cues and incivilities. Comparative analysis with an AI-generated (ChatGPT) questionnaire demonstrated the superiority of the co-created version in contextual sensitivity and content validity. The final co-created questionnaire consists of six sections covering demographics, commute-related exposure, private green space use, most used public green spaces and detailed exploration of the two most frequented types of green spaces. A parent proxy version of the questionnaire was also developed.

Conclusions: This developed questionnaire serves as a novel tool for assessing adolescent's green-space exposure in future epidemiological and public health studies, and urban planning.

Key Words: Green Space Exposure, Adolescents, Co-creation

Résumé

Contexte : Les adolescents sont particulièrement sensibles aux facteurs de stress environnementaux, ce qui rend leur interaction avec les espaces verts cruciale pour leur développement physique, mental et social. Bien que la recherche existante souligne les bienfaits de l'exposition aux espaces verts sur la santé, comment les adolescents accèdent, utilisent et perçoivent les espaces verts reste peu étudié. **Objectif :** Co-créer un questionnaire adapté aux adolescents pour évaluer l'exposition aux espaces verts publics chez des adolescents français selon trois domaines : usages, services et perception. **Méthodes :** Une revue de la littérature a permis d'élaborer une première structure de questionnaire. La génération de connaissances participative a consisté en :(i) un atelier de co-création avec trois adolescents garçons (12 et 14 ans) à Rennes, (ii) une discussion en groupe avec onze experts en santé, et (iii) une analyse comparative avec un questionnaire de référence généré par ChatGPT. Les apports ont été synthétisés de manière itérative pour affiner le contenu, la formulation et la structure du questionnaire. **Résultats :** L'atelier avec les adolescents a montré qu'ils fréquentent les espaces verts à la fois de façon intentionnelle et incidente, en particulier lors de leurs trajets quotidiens. Ils considèrent les cours de récréation et les espaces verts informels comme importants et ont défini huit types d'espaces verts selon leur fonctionnalité. Les variations temporelles d'accès (p. ex. semaine vs week-end, période scolaire vs vacances) sont apparues comme un facteur déterminant. Le groupe d'experts a souligné l'importance de saisir cette variabilité temporelle, de définir les espaces verts selon leurs fonctions. Le jardin privé a été identifié comme un facteur de confusion potentiel et traité dans une section spécifique du questionnaire. Les experts ont également insisté sur la nécessité d'évaluer à la fois les stimuli sensoriels positifs et les nuisances/« incivilités ». L'analyse comparative avec le questionnaire généré par l'IA a démontré la supériorité de la version co-créée en termes de sensibilité contextuelle et de validité de contenu. Le questionnaire final co-créé comporte six sections couvrant : les données démographiques, l'exposition liée aux trajets quotidiens, l'usage des espaces verts privés, les espaces verts publics les plus fréquentés et une exploration détaillée des deux types d'espaces verts les plus utilisés. Une version proxy destinée aux parents a également été élaborée. **Conclusions :** Ce questionnaire constitue un outil inédit pour évaluer l'exposition des adolescents aux espaces verts dans les futures études épidémiologiques et de santé publique ainsi qu'en aménagement urbain.

Introduction

Green spaces refer to either natural areas or urban parks and wetlands that comprise some vegetation. It is usually composed of vegetation and is usually, but not always, associated with natural elements. For adolescents who are in a key period of development, these spaces serve as critical environments for play, exploration, socialization, and restoration.(1) Beyond recreation, green spaces are increasingly recognised for their role in promoting physical and mental health, encouraging physical activity and supporting cognitive and emotional development.

However, with growing urbanisation, the pressure on existing green spaces has increased several times, not only affecting quantity, but also quality.(2) Globally, the last thirty years have witnessed a significant decline in green spaces in urban areas.(3) In Europe alone, nearly sixty percent of the population lack access to green spaces in their daily life.(4) These disparities are further exacerbated by socio-economic inequalities, with vulnerable communities facing greater barriers in accessing and interacting with these spaces. Urban planning and public health frameworks are increasingly recognizing the role of green infrastructure in promoting sustainable and equitable cities. Yet, the specific needs and experiences of adolescents are rarely centred in these discussions.

The Role of Green Spaces in Promoting Human Health

Green spaces, encompassing both natural areas and urban vegetation like parks, gardens, forests, and wetlands, provide extensive health advantages. Research over the last few decades has consistently highlighted the comprehensive health benefits derived from exposure to green spaces, impacting mental health, cognitive development, cardiovascular health, chronic disease prevention, and mortality.(5)

Increased proximity and engagement with green spaces are strongly associated with reduced depression, anxiety, and psychological distress, alongside improved cognitive functions. These mental health improvements extend beyond physical activity, driven by enhanced emotional restoration, stress recovery, social cohesion and cognitive development in biodiversity-rich environments.(6) Specifically, green spaces have been found to foster emotional and behavioural development among children and adolescents, reducing ADHD symptoms and enhancing cognitive abilities partly through reduced air pollution exposure.(7) Adolescents particularly benefit from green spaces due to their critical neurodevelopmental

stage, supporting cognitive and emotional regulation, resilience building, and facilitating social interactions and autonomy.

Cardiovascular health also significantly benefits from green space exposure. Studies indicate that increased exposure to vegetation-rich areas is consistently associated with reduced risks of cardiovascular disease (CVD), including stroke, coronary heart disease, and cardiovascular mortality.(8) Evidence from meta-analyses indicates that higher levels of normalized difference vegetation index (NDVI), a common metric for measuring greenness or vegetation, are significantly correlated with lower risks of cardiovascular events.(9) For instance, in the United States of America, a 0.1 unit increase in the Normalized Difference Vegetation Index (NDVI) within 1000 meters has been associated with a 16% reduction in CVD risk.(10) Furthermore, living near greenspaces correlates with less severe clinical manifestations of cardiovascular conditions, such as lower rates of severe arterial stenosis and decreased myocardial injury markers. These cardiovascular improvements arise primarily by mitigating risk factors such as hypertension, dyslipidaemia, diabetes, and obesity, through mechanisms including improved cardiometabolic health, lipid profiles, and blood pressure regulation.(8) Enhanced vascular health, reduced oxidative stress, and lowered sympathetic nervous activity are pivotal pathways facilitating these outcomes.

Furthermore, green spaces offer protective benefits against chronic conditions such as type 2 diabetes. Studies over the past decade have highlighted that exposure to green spaces can protect against the development of diabetes.(11) In China, a population based health study among the Henan Rural Cohort, found that the residential green space was associated with lower fasting blood glucose levels in men and the elderly.(12) While in the United Kingdom, elevated residential green space level was associated with lower risk of incident Type 2 Diabetes Mellitus. Globally, despite regional variability, the beneficial association between green space exposure and human health remains robust.(13)

Possible mechanisms of positive health effects

Green Spaces provide health benefits to populations that use or are exposed to them. The mechanisms linking green spaces' impact on an individual’s health are complex and interacting, often with a synergistic effect.(5) Although there are various pathways, I summarise the mechanism of effect through four domains i) Mitigation : Reducing harm by decreasing levels of environmental pollution (air, noise, urban heat island etc.), ii) Immunity Building - increasing skin and nasal microbial diversity and enrich human microbiota composition, iii) Restore capacities (attention restoration, physiological stress recovery) and iv) Build

Capacities through socio-behavioural mechanisms (encouraging physical activity and facilitating social cohesion).(14)

Mitigation

Green spaces have emerged as a critical element for ecological sustainability and climate change mitigation.(15) They function as vital 'environmental capital' delivering a suite of regulating ecosystem services that help directly mitigate the consequences of climate change and pollution.(16) Green spaces sequester atmospheric CO_2, buffer extreme heat through shade and evapotranspiration, filter air pollutants, slow storm-water run-off and, by supporting diverse flora and fauna, underpinning broader ecological resilience.

An increasingly recognised benefit is temperature regulation, particularly in response to the growing phenomenon of urban heat islands (UHI), whereby cities experience higher air temperatures than the surrounding countryside, due to the extensive heat absorbing materials like concrete and asphalt.(17) Currently, these urban heat islands have become a major challenge for cities and pose significant health risks, by heightening air temperatures and intensifying heat waves to cause heat stroke, exhaustion and other illnesses like heart attacks.(18) In addition to the endangerment of the population living in concrete jungles, to cope with higher temperatures, cars and buildings consume more energy which in turn worsens air pollution and contributes further to climate change. Green spaces, especially urban vegetation, buffer heat stress and have proven effective through shading by vegetation or canopy cover and transpirational cooling.(19–22) Cities and communities worldwide are increasingly exposed to intensifying climate impacts that require urgent solutions and long-term momentum to advance climate adaptation.

Beyond the mitigation of the growing and often life threatening effects of climate change, green spaces constitute an important factor in pollution, especially in dense urban areas. The two major environmental contaminants are air and noise pollution.

Air pollution is one of the biggest public health threats globally, causing more than 4 million premature deaths each year and significantly reducing overall public health. Green spaces affect air pollution and quality both directly and indirectly.(23) One of the primary mechanisms by which green spaces improve air quality is through vegetation, which captures airborne particulate matter (PM) on their surfaces. Additionally, soil microbes supported by vegetation can break down harmful pollutants, including nitrogen oxides and volatile organic compounds, contributing to a cleaner atmospheric environment.(24) Beyond physical removal, green

spaces can also influence local microclimates by reducing temperatures and altering wind patterns, further affecting pollutant dispersion and concentration.(25)

Individuals living in urban cities may also be exposed to harmful levels of environmental noise exceeding 55 dB as defined by the WHO.(26) The environment is not healthy in most urban cities, and this situation has not changed for several decades.(27) Noise is considered as the second leading environmental cause of disease in European omnipotent and intrusive pollutants in the current world, having serious auditory and non-auditory health effects.(28) It is a major preventable cause of hearing loss.(28) In 2010, the Global Burden of Disease estimated that 1·3 billion people are affected by hearing loss, with it being rated as the 13th most important contributor (19·9 million years, 2·6% of the total number) to the global years lived with disability (YLD).(29) Non auditory health effects range from annoyance, sleep disturbance, cardiovascular disease and serious cognitive impairment in children and adolescents.(30) Green spaces, on the other hand, have the ability to mitigate noise pollution. They can reduce noise, because of the incident of absorption, refraction, and reflectance and become noise buffers. The Department of Forest Research of the United Kingdom, estimates a green space with trees and shrubs can reduce noise by five to ten decibels for every 30 m width of woodland, especially sharp tones, and this reduces noise to the human ear by approximately 50%.(31)

Immunity Building

In urban societies, there has been a dramatic rise in chronic inflammatory diseases, including allergies, autoimmune disorders. This trend is partly attributed to the failure of immunoregulation, where the immune system mistakenly targets tissues in the human body. Several hypotheses including Hygiene, Old friends and Biodiversity, each suggest mechanisms that can explain why an urbanised lifestyle may be associated with decreased human microbial diversity.(32–35) For example, urbanisation is associated with a decrease in outdoor environmental exposure leading to reduced environmental microbial diversity, creating a critical gap in immune system education. Green Spaces offer a unique ecosystem service of acting as reservoirs of the missing microbial diversity, where the interaction of an individual with green spaces, leads to airborne microorganisms from soil, plants and water bodies being inhaled, deposited on the skin and ingested, continually stimulating the immune system. Several rigorously established epidemiological studies have shown that exposure to rural green spaces or agricultural areas to have a greater diversity of skin and gut microbiota, thus displaying stronger immunoregulatory responses correlating with lower incidence of asthma, allergies and inflammatory bowel disease.(36–38)

Restore Capacities

Kaplan in 1989 and 1995, put forth a theory, Attention Restoration Theory (ART) suggesting that mental fatigue and the ability to concentrate can be improved by the time spent in, or looking at nature.(39) People's capacity for attention recovers in restorative environments, including natural environments, that offer qualities of "fascination," "being away," "extent," and "compatibility. A second theory - psycho evaluation theory, that wanted to explain the restorative effect of nature, was proposed by Ulrich in 1983.(40) It is based on the assumption that human physiology has evolved in a natural environment and because of this, our brain and sensory systems are tuned to efficiently process natural content. While both theories have been widely cited and are with merit, Valtchanov *et al*. in his paper suggests a missing link which is a visual reward mechanism for restoration.(41)

Consistent with these theories, well established and a growing body of research have found evidence, indicating that these natural environments, called "restorative environments" have significant beneficial effects on restorative psychological and physiological effects on people, including stress relief and fatigue recovery.(41–44) Several studies with adults have found consistent evidence, indicating that exposure to nature and green spaces predicts restoration from stress, lower levels of mortality and illness and can have a positive impact on mental health and restore capacities, including memory and attention.(45) While these effects were observed in adults, a significant body of research has demonstrated that these benefits are also applicable to children and adolescents, and perhaps have a magnified effect, as their restorative capacities are still developing.

Build Capacities

Apart from restoring capacities, green spaces are an important resource to deepen and strengthen capabilities for meeting everyday demands. In the green spaces discourse, less focus has been paid to this important mechanism. One important way it builds capacity is through encouraging physical activity. Evidence suggests that physical activity may play a strong mediating role between exposure to green spaces and health, with one of the most influential factors on green spaces usage is proximity or distance to nearest green space.(46–48)

Another important pathway green spaces build capacity is through facilitating social interactions and social cohesion. Social cohesion refers to the extent to which people in society

are bound together and integrated and share common values.(49) These social interactions and social cohesion within communities are related to health and well-being.(50,51) Several studies have found that residents in communities and neighbourhoods perceived the social health benefits of green spaces, including improved interpersonal management and promotion of social relations.(52–54)

Other ways to build capacity through green spaces are transcendent experiences of awe, humility, reflection, etc., and promote place attachments and place identity.(14) These transcendent experiences elicited through engagement with natural sights and sounds, enhance emotional well-being and provide deeper perspectives on life priorities, while contributing to overall psychological health. Research has shown that the viewing of types of wildlife contributed to a sense of humility and awe and that the number of habitat types, species richness of plants and birds were positively associated with reflection. Additionally, green spaces promote emotional bonds, leading individuals to develop place attachment and place identity to green spaces or biodiverse environments.(55–60) These emotional bonds to specific natural environments enhance psychological well-being and strengthen personal and community identity.(60,61)

While these four pathways highlight the multifaceted pathways in which green spaces benefit human health, it is crucial to recognise that certain stages of life form building blocks to future development and are particularly sensitive to environmental influences.

Adolescence: A Critical Window for Environmental Influences on Development

Adolescence is the transitional period of life between childhood and adulthood, mainly from ages 10 (or 12) to 19 years.(62) It is a uniquely important stage and a critical building block for human development, characterized by rapid physiological changes and psychological maturation. Individuals experience significant physical, emotional, social, cognitive, sexual, identity and moral changes. These domains of development are often interwoven and interdependent, but also highly susceptible to the social and environmental stressors around us.(63)

The three Domains of Adolescence development as described by the National Academy of Sciences, USA are classified into Puberty, Neurobiological development and Psychosocial development. Puberty is both a biological and social process.(64) Biological puberty in adolescence occurs over an extended period of time, encompassing neuroendocrine changes that lead to development of primary and secondary sexual characteristics and the acquisition

of reproductive maturity. It is influenced by various genetic and environmental factors including early life experiences. This period is also marked by extensive neurobiological development, offering remarkable opportunities for growth due to the brain's heightened plasticity. This plasticity of the brain is characterized by a peak in sensation seeking behaviour, enhancing adolescents' propensity for risk-taking, exploration, and social engagement, essential for developing the cognitive, emotional, and social skills needed in adulthood.(65) These tendencies play an adaptive role in fostering experience that supports individuation during the transition to adult roles and responsibilities.(66)

While developmental plasticity in adolescence bears advantages, as with all aspects of development the environment plays a significant role. The malleable brains of adolescents, while being adaptable to innovation and learning, is also increasingly vulnerable to environmental stressors and toxic experiences. Recent studies have indicated that green spaces can tilt the balance towards building resilience by dampening stress-reactive cortisol, moderate and support healthier pubertal trajectories.

Given this developmental context, green spaces represent a critical, yet often underutilized, resource that can development. Exposure to natural environments supports cognitive and emotional regulation, buffers stress, enhances resilience, and fosters a greater sense of autonomy and purpose, precisely the developmental needs highlighted in earlier discussions.(67) In a recent review of systematic reviews, 15 systematic reviews reported a strong positive association between green space exposure and different neurodevelopmental outcomes.(67) A total of 11 of them reviewed cognitive outcomes finding strong association between green space exposure and cognitive development, language, motor and social abilities.(68) Roughly half the studies found positive gains in brain development outcomes including working memory, cognitive performance, and white and grey matter volume in different regions of the brain.(68) In a parallel set of reviews, seven out of eight found the beneficial role of green space on behavioural outcomes, mainly problematic behaviours.(69)

Green spaces provide adolescents with safe environments where they can engage in risk-taking within healthy limits, build social relationships, and explore meaningful activities, all of which facilitate positive identity formation and emotional development.

Defining and Classifying Green Spaces: Current Approaches and Limitations

Taylor et.al, after a comprehensive review among multiple disciplines found two interpretations of green space that provide more functional understanding.(70) The first one refers to areas of vegetation or bodies of water in various landscapes, referring to the overarching concept of nature or natural areas. The second interpretation is a subset of the overarching concept of green space that is confined to the urban environment - urban vegetation. It includes parks, gardens, yards, urban forests, urban farms, usually relating to vegetation covering open space. They summarise that the current definitions of greenspace are broad and complex and in Public Health studies we prefer to be quantitative due to us preferring the criteria of size of green space and accessibility.(70)

Green spaces are a variety, such as parks and gardens, housing green spaces, community woodlands, sports fields to street trees. Different countries tend to have different types of green spaces based on location, geography, climate and environment, socio-economic states and culture of that country.(71) In many countries, they are stated in a set of different administrative regulatory frameworks, especially for urban planning, with their definition and characteristics inconsistent.(72) Several researchers, communities or organisations have tried to standardise the classification.

The department of Forest Research, by the government of United Kingdom, classify the types of green spaces into Community woodlands, Green roofs, Landscape around buildings, Street trees, Urban parks and gardens and Wetlands.(71)

An online community from the United Kingdom called urban rambles, has classified urban green spaces based on three criteria, their origin, development and walkability.(73) Based on this classification green spaces can be broadly classified into tended green spaces for pleasure (squares, botanical gardens, parks etc.), tended green spaces for use (allotments, playgrounds, cemeteries etc.), untended green spaces (wasteland, disused railway lines etc), water features (rivers, lakes, ponds, canals dockyards etc.), natural green spaces (meadows, health’s, woodlands), and controlled green spaces (green belt and nature reserves).

Researchers in southern Sweden, have developed a novel index score, The Scania Green Score (SGS), basing it on area-level proportions of perceived availability of five qualities of the green neighbourhood environment, culture, serene, lush, spacious and wild, which can be used in epidemiological studies.(48) At the same time, urban planners in Beijing, China, classify the type of urban green spaces as Park green spaces, protection green spaces,

institutional green spaces, residential green spaces, street green spaces and vacant land spaces.(74) While Ranjha, Shikha for his thesis on maintenance of neighbourhood parks in Delhi India has compiled a comprehensive list on the types of green spaces.(75)

- Parks and gardens
- Natural and semi natural green spaces
- Green Corridors
- Amenity Green spaces
- Cemeteries
- Religious places
- Horticulture space.

Currently as there is no consensus or a recommended definition on green spaces, for the purpose of the creation of a tool, a questionnaire that can be implemented in epidemiological studies and is comprehensive towards adolescents use, we will accept both the interpretations, and try to not only be constrained by our quantitative need, but also look into qualitative aspects, focusing more on a functional approach, letting adolescents identify and classify green spaces, through the time they interact with green spaces - 15 mins in a day.

Research Gaps and the Need for Adolescent-Centred Assessment Tools

Current epidemiological studies predominantly utilise the Normalized Difference Vegetation Index (NDVI) as the greenness indicator regardless of the type of outcome.(7) NDVI is a popular proxy for assessing green space exposure. It has several strengths such as ease of access at multiple time points for around four decades, which facilitates comparisons across studies and time periods.(76) However, NDVI is a relatively crude measure, especially when considering outcomes such as allergic responses or mental wellbeing, since it does not differentiate between types of vegetation or capture aspects of green spaces, such as biodiversity, maintenance, or user experience.

In addition, studies in the intersection of green spaces and health benefits or outcomes are well documented in early childhood and adults, adolescence remains underexplored despite being a critical building block of human development. Moreover, adolescents are likely to interact with green spaces differently from children or adults, yet their perspectives and usage are rarely captured.

To address this critical gap, there is a need for more nuanced assessment that goes beyond greenness quantity. We require a comprehensive understanding of how adolescents interact with green spaces, including their perception of it, what they use it for, what services are

available to them, their accessibility of the green space, safety and security. This will be essential to inform not only future epidemiological or public health studies, but also inform urban planning and policy strategies aimed at promoting development and resilience.

Therefore, I aimed to develop a questionnaire to assess the types of green spaces, accessibility, usage patterns and perception of green spaces among adolescents.

Methodology

Framework

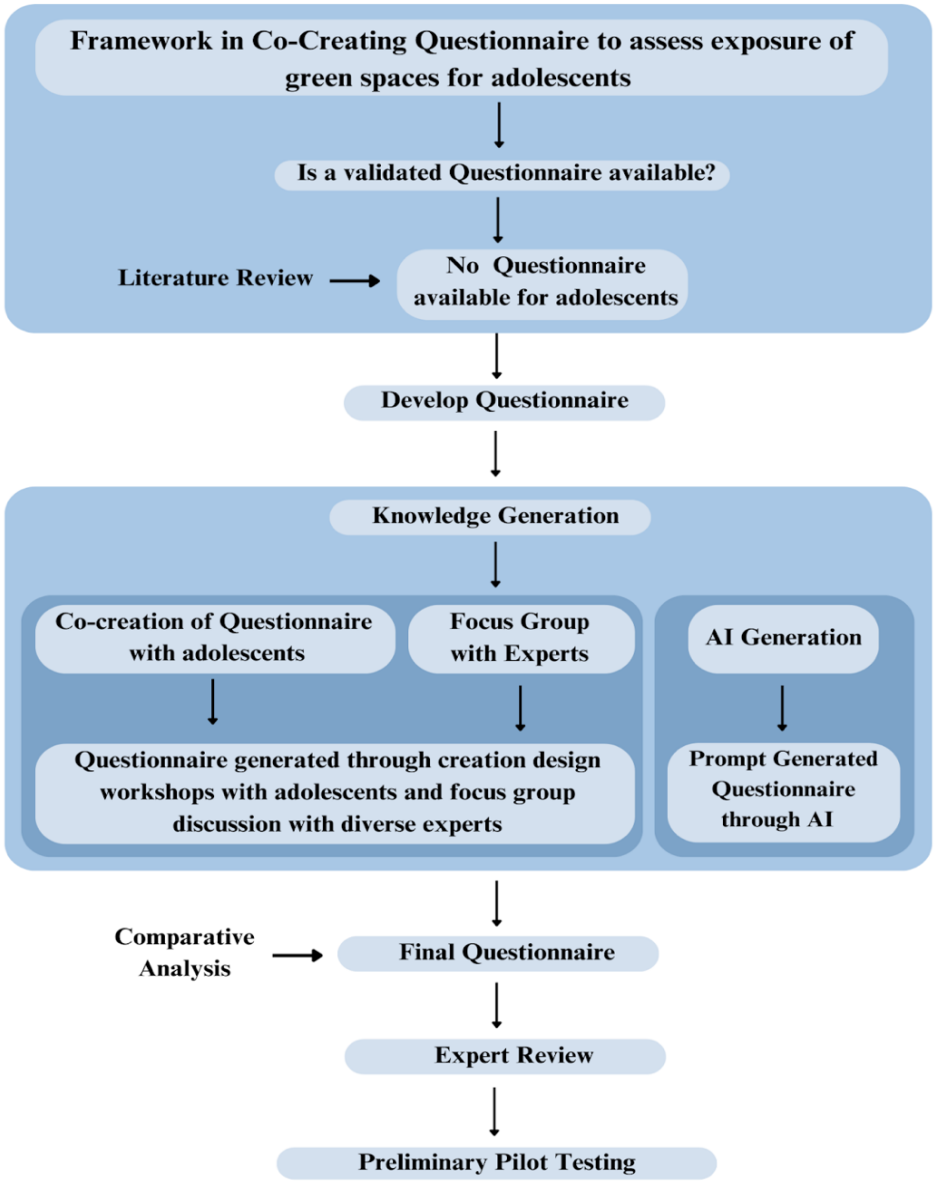

Figure 1. Framework in Co-creating Questionnaire to assess exposure of green spaces for adolescents

Literature review

To inform the needs to develop a new study to assess the exposure of green spaces among adolescents under the domains of usage patterns, services available and perception, an initial scoping review of academic and grey literature was conducted. The search was exploratory and iterative, conducted across multiple search engines and databases, including PubMed, Google scholar, Google and Bing, using Boolean operators “AND” and “OR” . Keywords commonly combined included “green space”, “urban green space”, “health”, “perception” etc.

The review aimed to identify existing validated or pre-validated instruments or frameworks that capture adolescents' interactions with green spaces in one or all domains we were considering for the study. Information related to green spaces, their types, accessibility, temporality of use, benefits they provide adolescents, services and any relevant questionnaires or scores were also collected. The diversity of relevant domains, such as types, services and perception, necessitated the inclusion of grey literature from reports, urban planning documents and community websites to capture contextual and practical insights absent from the peer reviewed databases.

Despite this broad approach, no existing questionnaire or instrument was identified that holistically or individually captured adolescent’s use, perceptions and experiences in green spaces. As a result, a new questionnaire was to be developed that ensured centralised adolescent participation. To achieve this, we conducted one co-creation workshop with adolescents and a focus group discussion with experts, allowing us to collect adolescents’ personal opinions and also emergent, confluent, or divergent ideas. A questionnaire with the three domains (Use, services and perception) was developed prior to the focus group and co-creation workshop to use as a template for the sessions. It was comparatively analysed with a questionnaire generated using generative Artificial Intelligence, ChatGPT using a simple prompt to assess the exposure of adolescents to green spaces, with focus on three domains usage, available services and perceptions. ChatGPT basic model, which is available for free to the general public, was used to generate this questionnaire.(77)

Participants and Settings

Participants for both the expert focus group and adolescent co-creation workshop were recruited based on convenience sampling, and were interviewed in Institut de recherche en santé, environnement et travail (IRSET) in Rennes. A total of 11 experts from different disciplines (environmental epidemiology, healthy urban planning, biostatistics, expology etc.) were interviewed along with 3 adolescents during the co-creation workshop. No personal information was collected.

The studies objectives, methodology, and how discussion would be conducted were explained to all participants. Informed consent was provided by all adult participants in the focus group. For the co-creation workshop, participant's legal representatives were contacted via phone or word of mouth, and an invitation to the participant was made. For accepting participants, consent was asked from both them and their legal representatives, with a guardian physically present during the session. Both the focus group and the co-creation workshop followed a semi-structured guide that was developed earlier.

Knowledge generation

Adolescent Co-Creation Workshop

Traditionally public health interventions or research are predominantly developed using a top-down approach, grounded in extensive evidence or are often based on a behavioural change theory, often excluding end-users.(78) In our case,' adolescents'. The development of tools for research in child and adolescent health requires particular considerations and cannot merely be adaptations of adult programmes. The content and design of the programme requires a developmental or age-appropriate approach, accounting for a range of interests and tastes of adolescents.(79) Co-creation rooted in participatory design, involves users and stakeholders directly to ensure tools and technologies meet their needs and are widely accepted.(79) Using co-creation as a participatory technique allows adolescents and stakeholders to be actively involved in the development and implementation of the actual intervention for specific settings and is a promising approach to increase engagement among adolescents.(80)

Jones et al. in their review detailed methods of engagement for young participants. including the use of icebreakers, interactive and creative activities (e.g., drawing, storytelling, video creation), and tools like mood boards and mobile devices. Safety and wellbeing considerations were emphasised, including offering refreshments, creating enough space, regular breaks and giving clear 'ground rules'.(79)

The co-creation workshop for adolescents followed a guide developed prior [Appendix], adopting one such method of engagement, 'gamification'. In alignment with the safety and wellbeing considerations, the session began with a clear explanation of the objectives and methodology of the project. To foster a comfortable environment, an introductory icebreaker was used, asking each participant in one word to describe your best outdoor space.

The session involved three adolescent participants and lasted approximately 70 minutes, facilitated by a moderator and a note taker. Refreshments were offered throughout the session. The workshop was structured into four participatory activities:

1. Story Mapping - where adolescents reflect on a typical day and how they encounter or engage with green spaces in their daily routines. This helped surface habitual interactions and contextualized green space use from the adolescent perspective.
2. Design Your Own Questions Challenge - participants developed their own questions on themes such as accessibility, usage, and safety. They then pitched their favourite questions to the group. This activity surfaced priorities and the natural language adolescents use, supporting questionnaire relevance and age-appropriate framing.
3. Photo Prompts - Participants were shown five images depicting different green spaces (parks, forests, cemeteries, sports fields, abandoned lots). They were asked whether they would visit those places and what kinds of questions should be asked about them. This aimed to elicit perceptions and attitudes towards diverse green environments.
4. Emoji Rating- Participants rated the clarity and relevance of questions using emojis (good, okay, confusing). Questions rated as ‘okay’ or ‘confusing’ were discussed and revised collaboratively.
5. Voting - Participants voted on each question to prioritize which sections and questions they felt were most important.

Focus Group discussion

The focus group discussion was conducted with a panel of experts in relevant fields such as environmental health, adolescent health, epidemiology, and urban planning. It followed a semi-structured guide [Appendix]. The session involved 11 participants and lasted two hours, facilitated by moderators and a designated note-taker. The focus group began with an introduction to the project, followed by an interactive ice-breaker using the Menti-meter tool to identify top priorities regarding green space use for adolescent health and well-being.

Subsequently, the template questionnaire was presented, and the rationale behind each section was explained to solicit preliminary feedback on content, missing constructs, and the demographic profile. The main component of the focus group consisted of a "rotating chairs" activity, where participants were divided into small groups and rotated among three themed tables (Usage, Services, Perceptions), each moderated by a facilitator. Experts at each table engaged in structured discussions, offering detailed feedback and suggestions: the Usage

section focused on open-ended discussions around question relevance and barriers to honest reporting; the Services section utilized coloured pens to prioritize needs and suggest improvements; and the Perceptions section emphasized measurement clarity and the selection of appropriate validated scales.

Additional time was allocated to discuss the inclusion and structure of a parent questionnaire, exploring its necessity and clarity. The session concluded with a rapid group synthesis to distinguish between essential, desirable, and unnecessary questions, followed by a collection of final recommendations.

Discussions were audio recorded, so they could be then transcribed and analysed.

AI generation

"*Generate a structured, age-appropriate questionnaire for adolescents (12–18 years old) assessing their exposure to green spaces, including dimensions of usage, available services and perception",* was used as the prompt for ChatGPT to generate a questionnaire [Appendix].

Ethical Considerations

No ethical approval was necessary since personal information was not collected and all participants were anonymised. Participants of legal age provided consent. For participants below the legal age of 18, verbal consent was obtained from both the participant and their legal guardians (parents), along with authorisation for recording the workshop.

Results

Adolescent co-creation workshop findings

During the co-creation workshop, an early finding that emerged was that adolescents interact with green spaces in both intentional and incidental ways. They reported walking past green spaces, such as parks or tree-lined pathways, on their way to school or while walking their pets, but however they emphasised a clear distinction between walking through these spaces and actively using them. One participant noted, "*Je traverse le parc pour aller à l'école, mais je n'y reste pas.*" (I walk through the park to go to school, but I don't stay there). Another finding that emerged was that adolescents consider school yards to be a green space. Schoolyards

were frequently mentioned, although adolescents emphasized their limited vegetation and lack of “real greenery”, and only with trees or patches of green grass.

While this was initially not in our considerations while drafting the questionnaire framework [Appendix] and structure, the workshop demonstrated that adolescents demonstrated an intuitive understanding of green spaces, their classifications reflected their lived experience rather than research or formal planning terminology.

While formal classifications have merit and most are very comprehensive, for the purpose of this study to assess the exposure of green spaces on adolescents, we decided to compile a separate classification that would capture the interaction of French? adolescents with public green spaces from their perspectives. The co-created classification with adolescents [Table 1].

S.no	Type	Description	Function
1	Urban parks / gardens / Squares	Well-maintained public areas with benches, paths, some trees or flower beds; accessible from residential areas	Relaxation, socializing, walking pets, running, occasional gatherings
2	Forests / Woods	Dense natural vegetation, sometimes at the outskirts of town or in designated zones, used occasionally	Peaceful retreats, aesthetic appreciation, occasional walks with family
3	Green Trails / Pathways	Linear green spaces with trees or grass, often used for walking or cycling routes	Commuting, cycling, running, walking with friends or alone
4	Open Grassy fields	Unstructured open land, sometimes adjacent to housing or parks, used informally	Free play, informal gatherings, occasional sports
5	Playgrounds	Play equipment present, usually targeted for younger children but still used socially by teens	Active play, social interaction, informal hangouts

6	School grounds with green	Green areas within school premises, often limited in vegetation and used during breaks	Physical education, recess, sometimes gathering during free time/period
7	Outdoor sports fields	Spaces designated for sports like football, basketball, tennis, volleyball or skate parks with grassy or semi-green surroundings	Organised or casual sports activities, physical engagement
8	Religious green spaces with green	Church gardens, cemeteries, or green cloisters, vegetation exists but limited recreational use	Occasional reflection, aesthetic experience, low regular use

Table 1: Types of Green Spaces, co-created with adolescents

With different types of green spaces, temporality of use of these green spaces were brought up as a key insight. The adolescents recognised using different green spaces, based on different periods of time, with one participant suggesting to ask "*green spaces you most visited on weekdays , the one on weekends, the one on holidays*".

Adolescents also associated their ideal green spaces with size, quietness and natural features like trees and open fields. Words like "calme" and "grand" were used to describe their ideal green environments, expressing preference towards spaces that felt expansive and natural. Participants also preferred spaces that 'looked nice', suggesting visual quality or aesthetic value beyond regular ecological function.

In regards to accessibility, safety and services. Accessibility to green spaces was shaped by proximity, transport options, and parental permission. Distance was cited as a limiting factor. Safety was also a recurrent theme. Cleanliness and the presence of others also shaped perceptions of safety, with a participant noting *"C'est mieux quand c'est propre et il y a du monde."* Participants were also hesitant to use green spaces that lacked lighting or were poorly maintained. It was also noted that even though lighting was particularly important, however, too much artificial lighting was also viewed negatively. For services, participants expressed a need for both shaded areas for sun protection and covered zones for rain. Toilets and seating (e.g., benches, rocks, or tables) were identified as desirable but not always available.

A key motivator for green space use was social interactions. Participants discussed meeting friends, playing informal sports, and relaxing as primary uses. Interestingly, they distinguished between organized physical activity (e.g., EPS class or sports teams) and casual activity like kicking a football or strolling.

Towards perception questions, Positive experiences were associated with natural sounds (e.g., birds), clean air, and smells (e.g., flowers). Negative aspects included noise from roads or nearby playgrounds, litter, and muddy surfaces that hindered comfort and movement. Noise in general was viewed as something positive. They also wanted to make a distinction between wild fauna, as they would love to see donkeys, cows, or chicken.

Feedback from the expert focus group

The expert focus group convened explored what it actually means for young people to interact with green spaces and how a research tool or questionnaire can honour that complexity without exhausting the respondents, beginning with definitions, questionnaire structure and finally issues of validation and equity. The dialogue flowed in a loose narrative sequence and most insights that emerged were interconnected that helped us shape the final questionnaire.

Discussions started out with the questionnaire's scope and demographic details to collect. An early observation was that temporal nuance mattered. Patterns of use differ by weekday and weekend, especially for adolescents who are at boarding school or split time between two homes. A participant noted "*It's not always 50–50 between mother's place and father's, the teens' exposure may be different every week*." Additionally Boarding school schedules, parent's custody rotations and curfews mean weekday patterns diverge sharply from weekend ones, along with considerations of any holidays. The questionnaire therefore splits accessibility items by weekday or weekends, in different periods (school period or holidays) and also assess the time of the day they use green spaces along with frequency of use per week.

An initial question was on whether private gardens should be included. One participant worried that omitting them would erase the principle outdoor venues for many rural teens, while another participant cautioned that private gardens could "*leave out everything we are trying to capture about public green space exposure*". The group settled on a pragmatic solution, of having two opening items gauging ownership and use of private gardens, from whereon all subsequent questions explicitly reference public green spaces. This solution, falls back on my thesis argument for a functional definition that respects both epidemiological clarity and adolescents' lived realities.

Concerns over the length of the questionnaire surfaced early and often in the discussion, along with concerns of different usage and perceptions for different types of green spaces. The concerns over length were addressed during the adolescent workshop. Towards concerns on different usage and perceptions of different types of green spaces, the focus group decided to focus on two green space types most frequented in the last month, along with duplication of questions on usage, services and perception for these two types of green spaces.

Participants also observed that adolescents might not prefer to sit in chairs or benches in public green spaces like parks and might prefer places which are more quiet with little adult supervision or scrutiny. Quiet zones, informal seating, food availability on the way to the site and sports features (e.g. skate park) emerged as priorities.

As the initial framework of the questionnaire focused much on incivilities and nuisances faced by adolescents in green spaces, participants felt it was important to also measure the positive experiences, embracing a positive multisensory lens, encompassing "*what they see, hear, smell*" and "*not only what they think is harmful or annoys them*". Additional concerns centred on equity: would a city-centric instrument resonate with rural adolescents roaming forests? The group endorsed piloting in diverse settings and avoiding urban terms for green spaces.

Comparative Analysis of AI generated questionnaire

Chat-GPT generated questionnaire [Appendix] captures useful core information on adolescents' exposure to green spaces, providing a 'neutral baseline' for the questionnaire. The comparative analysis is shown in Table 2.

Domain	**Generated questionnaire**	**Findings from comparative analysis with co-creation discussions.**
Demographics	Age, gender, residence type (urban/suburban/rural)	It misses the living-arrangement situations and temporal split.
Types of Green Space	Limited list of types (park, playground, forest, school garden, private garden)	The list is generalised and not specific or expansive enough to cover all the types of green spaces that adolescents use.

Intensity and temporality of use	Single frequency question	Combines all visits together and cannot capture temporal or place-specific patterns.
Accessibility	Distance categories and safety perception	The questionnaire lacks transport/time items and misses out any items on commute.
Services / facilities	Single question on service or facility improvement	Focuses more on improvements to green spaces and fails to ask about the current services in these green spaces
Perception / experience	Single safety item with another on availability	The questionnaire's perception block is minimal; rich sensory & evaluative items are missing.
Barriers & incivilities	Specific item list (lack of time or interest, distance and safety concerns, and poor maintenance)	It contains some of the barriers, but is not comprehensive enough to capture most experiences or concerns.

Table 2: Comparative Analysis of ChatGPT generated questionnaire

Final questionnaire

The final adolescent friendly questionnaire [Appendix] that was co-created by adolescents and learning from the focus group discussion with experts comprises six sections, tracing adolescent exposure across personal background, daily routes and commutes and their two most used public green spaces. Section A gathers demographic details, having additional questions on living arrangement situations and boarding school status. Section B covers the school journey of adolescents focusing on their transport modes and how green their commute to school is. Private green spaces use is minimally explored as a separate section in Section C. Section D focuses on identifying the types of public green spaces utilised most by adolescents while also identifying the two most used types of green spaces. Section E and Section F comprehensively covers questions on usage, timing, access, services, perceptions and incivilities of the most utilised types of green space, green space 1 and green space 2 respectively. While most questions are itemised, questions on perceptions use either a three option format (yes, no and I don't know), or had a four point Likert.

Finally a parallel parent proxy questionnaire was also adapted to be used by parents of the adolescents, rewording each question from the caregiver perspective, for future use to understand the degree of agreement between parents and adolescents.

Discussion

Main findings from the development of the questionnaire

The combination of a co-creation workshop with adolescents along with a focus group discussion with experts in health has yielded a nuanced understanding of the interaction of adolescents with green spaces in France.

Early on in the discussion, it became evident that adolescents consider their school yards with limited vegetation as green spaces, a point which the researchers themselves along with the experts did not consider. The types of green spaces summarised in the questionnaire reflects their perspective. This is important as Prins *et al*. found that perceived environment_has different associations with health behaviours as compared to objectively measured environments.(81) They found that in adolescent girls, only perceived environment was associated with moderate to vigorous physical activity.

The adolescents in our workshop regularly use green spaces, especially when they are part of their daily trajectories. Yet their interactions with traditional green spaces is rather limited on average, as compared to green spaces in or near their schools and homes, which may not entirely be available to the public (school yards) and which serve a functionality like sports area or football pitch.

A key insight by both groups was the importance of recognising the temporal dimensions in green spaces use among adolescents. Adolescents' interactions vary significantly between weekdays and weekends in school periods and holidays, along with other factors including parental custody arrangements, boarding school attendance and curfews. The temporal distinction was critical to avoid oversimplification in assessing green space exposure, leading the final questionnaire design to differentiate usage patterns across weekdays, weekends and holidays along with frequency and timings of visits.

Another temporal dimension considered in the green space was the definition of exposure to green space by adolescents. While there is no existing objective criteria, prior studies on

adults, studies have classified respondents based on frequency of visits. For example, those who have visited an urban green space more than once per week within the past two weeks as “heavy user group” and once within the past two weeks as “moderate user group”. This approach was with limitations, especially for the target group being adolescents, whose routines and patterns are more variable and context dependent. We instead tried to not only be constrained frequency focusing more on a functional approach, letting adolescents determine the number of days they interact with green space, through the time they interact with green spaces - 15 mins in a day for the last 3 months. This threshold was chosen not only for feasibility in recall but to also capture engagement of adolescents in different seasons, in case the questionnaire is used bi-annually or seasonally, to capture intentional use and incidental interaction during their daily routines.

Interestingly contradictions emerged between experts and adolescents regarding their use of public services. While the expert group felt that adolescents would generally not prefer sitting in public chairs or tables, often preferring quiet areas away from adult supervision, this was directly contradicted by adolescents who said they didn't feel that way, and usually do use public benches or chairs when in a green space. Interestingly it was also noted during discussion with adolescents that while they did use chairs or benches and tables in green spaces, they preferred sitting on top of them rather than sitting in them the usual way. This contraindication underscores the importance of co-creation with adolescents, to accurately capture behaviours and preferences to shape the questionnaire.

The questionnaire also reflects questions on whether the adolescents see or travel through green spaces or greenness on their way to school, as commutes through green environments benefit the cognitive development of children and most.(82) It is also important to take routine activity such as commuting to home or school into account for assessing green space accessibility, especially since in most studies difference in activity patterns per population age group, in this case adolescents are not accounted for.

Strengths

The study’s strengths stand out among existing literature in four ways. First, it is co-created with adolescents and not imposed by adults, letting teenagers classify the places that matter, set priorities, refine wording, while providing sound technical guidance on priorities from experts. Second, it measures exposure with far greater granularity than satellite based or NDVI studies or parent-report tools, that dominate current literature. The few adolescent questionnaires we located were short, did not differentiate among green spaces and often

ignored temporal nuances. Third, by using AI-generation, creating a questionnaire that is logically structured and free of individual researcher bias, drawn from a vast aggregation of previous survey practice, the comparative analysis, highlights jargon, blind spots and cultural or age sensitive assumptions the model missed, strengthening content validity. Finally, the structure of the questionnaire is pragmatic, keeping completion of the questionnaire under ten to fifteen minutes and making the instrument both seasonal and longitudinal.

Limitations

The study presents several limitations that must be discussed. Firstly, the sample used for both the focus group and adolescents co-creation workshop was a convenience sample, which inherently limits the generalizability of findings. The adolescents involved were recruited based on accessibility and availability rather than representative sampling strategies, which introduce bias regarding green space exposure, interactions and perceptions.

Only three adolescents of 12 and 14 years, significantly reducing the depths and variability of insights. Additionally, all of the adolescent participants were male and residing in Rennes, France, a city already characterized by extensive green infrastructure. This lack of gender diversity and geographic concentration further constrains the finding’s external validity, particularly when considering green space interaction from a girl’s perspective or adolescents from less green urban or rural environments.

Another critical limitation is the socio-economic homogeneity among the adolescent participants. Adolescents from minorities, such as immigrant communities, and adolescents with mobility or cognitive restrictions, were not represented. This absence due to convenience sampling might indicate missing factors which may prove critical in influencing green space accessibility and utilisation.

Regarding the focus group discussion with experts, all participants had professional backgrounds in health related fields. The lack of interdisciplinary perspectives, such as ecological, sociological or from urban planning might limit the comprehensive understanding of how adolescents interact and perceive green spaces and how best to capture these experiences.

Furthermore, the questionnaire focuses on only two types of green spaces most frequently visited by adolescents. Given adolescents' tendency to most visit and interact with green spaces in their daily life trajectories, this might lead to potentially omitting nuanced interactions

between adolescents and less frequented green spaces. Consequently, the full spectrum of exposure of adolescents to green spaces might not be captured.

Another limitation to the study is the minimal exploration of private green spaces in the questionnaire. As adolescents, particularly from rural and suburban settings frequently engage with private gardens or yards, the limited set of questions on private green spaces limit the understanding of total exposure, but given that this is beyond the scope of this study these constraints underline the need for future research.

Lastly, for the purpose of this thesis, time constraints meant that a full pilot study could not be conducted. However, we have started distributing the questionnaire and launched an ongoing pilot to assess practical applications, clarity, feasibility of the questionnaire in diverse settings and to validate the questionnaire. Findings from the pilot study will guide refinements and feed into further validation studies. As such the robustness of the questionnaire should be considered provisional.

Conclusion

Adolescents are a key demographic in the developmental continuum. Their heightened developmental plasticity, drive for individuation, growing sensitivity to social contexts make them extremely sensitive to their environment. The benefits to the mental and physical health and wellbeing of green spaces to adolescents, make them maybe the most critical age group to ensure access and exposure to green spaces.

The study's integration of expert and adolescent perspectives has significantly enhanced our ability to accurately capture adolescents' interactions with green spaces. This participatory approach ensures not only methodological robustness but also relevance and applicability, positioning the developed questionnaire as a valuable tool, ready for future epidemiological studies, both individual and cohort and urban planning efforts aimed at improving adolescent health, resilience and wellbeing through enhanced access to and engagement with green spaces.

References

1. Yu C, Weaver S, Walker M, Hess J, Mac A, Ross T. Opportunities for play in paediatric healthcare environments: a scoping review. Front Rehabil Sci. 2024 May 30;5:1415609.
2. Maas J, Verheij RA, Groenewegen PP, de Vries S, Spreeuwenberg P. Green space, urbanity, and health: how strong is the relation? J Epidemiol Community Health. 2006 Jul;60(7):587–92.
3. United Nations Human Settlements Programme. Cities and Climate Action, World Cities Report 2024 [Internet]. UN-Habitat; 2024. Available from: https://unhabitat.org/sites/default/files/2024/11/wcr2024_-_full_report.pdf
4. Barboza EP, Cirach M, Khomenko S, Iungman T, Mueller N, Barrera-Gómez J, et al. Green space and mortality in European cities: a health impact assessment study. The Lancet Planetary Health. 2021 Oct;5(10):e718–30.
5. Urban Green Space and Health. [Internet]. WHO Regional Officer for Europe; 2016. Available from: https://iris.who.int/bitstream/handle/10665/345751/WHO-EURO-2016-3352-43111-60341-eng.pdf?sequence=3&isAllowed=y
6. Xian Z, Nakaya T, Liu K, Zhao B, Zhang J, Zhang J, et al. The effects of neighbourhood green spaces on mental health of disadvantaged groups: a systematic review. Humanit Soc Sci Commun. 2024 Apr 5;11(1):488.
7. Zare Sakhvidi MJ, Mehrparvar AH, Zare Sakhvidi F, Dadvand P. Greenspace and health, wellbeing, physical activity, and development in children and adolescents: An overview of the systematic reviews. Current Opinion in Environmental Science & Health. 2023 Apr;32:100445.
8. Keith RJ, Hart JL, Bhatnagar A. Greenspaces And Cardiovascular Health. Circulation Research. 2024 Apr 26;134(9):1179–96.
9. Liu XX, Ma XL, Huang WZ, Luo YN, He CJ, Zhong XM, et al. Green space and cardiovascular disease: A systematic review with meta-analysis. Environmental Pollution. 2022 May;301:118990.
10. Yeager R, Riggs DW, DeJarnett N, Tollerud DJ, Wilson J, Conklin DJ, et al. Association Between Residential Greenness and Cardiovascular Disease Risk. J Am Heart Assoc. 2018 Dec 18;7(24):e009117.
11. Ccami-Bernal F, Soriano-Moreno DR, Fernandez-Guzman D, Tuco KG, Castro-Díaz SD, Esparza-Varas AL, et al. Green space exposure and type 2 diabetes mellitus incidence: A systematic review. Health & Place. 2023 Jul;82:103045.
12. Li R, Chen G, Jiao A, Lu Y, Guo Y, Li S, et al. Residential Green and Blue Spaces and Type 2 Diabetes Mellitus: A Population-Based Health Study in China. Toxics. 2021 Jan 16;9(1):11.

13. Yang T, Gu T, Xu Z, He T, Li G, Huang J. Associations of residential green space with incident type 2 diabetes and the role of air pollution: A prospective analysis in UK Biobank. Science of The Total Environment. 2023 Mar;866:161396.
14. Marselle MR, Hartig T, Cox DTC, De Bell S, Knapp S, Lindley S, et al. Pathways linking biodiversity to human health: A conceptual framework. Environment International. 2021 May;150:106420.
15. Department of Horticulture, School of Agriculture, Lovely Professional University, India, Athokpam V, Chamroy T, Department of Horticulture, School of Agriculture, Lovely Professional University, India, Ngairangbam H, Department of Agronomy, School of Agriculture, Lovely Professional University, India. The Role of Urban Green Spaces in Mitigating Climate Change: An Integrative Review of Ecological, Social, and Health Benefits. ER. 2024 Mar 20;6(1):10–4.
16. Gill SE, Handley JF, Ennos AR, Pauleit S. Adapting Cities for Climate Change: The Role of the Green Infrastructure. built environ. 2007 Mar 13;33(1):115–33.
17. Deilami K, Kamruzzaman Md, Liu Y. Urban heat island effect: A systematic review of spatio-temporal factors, data, methods, and mitigation measures. International Journal of Applied Earth Observation and Geoinformation. 2018 May;67:30–42.
18. US Environmental Protection Agency. Climate Change Indicators: Heat-Related Deaths [Internet]. 2024. Available from: https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths
19. Bowler DE, Buyung-Ali L, Knight TM, Pullin AS. Urban greening to cool towns and cities: A systematic review of the empirical evidence. Landscape and Urban Planning. 2010 Sep;97(3):147–55.
20. Armson D, Stringer P, Ennos AR. The effect of tree shade and grass on surface and globe temperatures in an urban area. Urban Forestry & Urban Greening. 2012 Jan;11(3):245–55.
21. Pataki DE, McCarthy HR, Litvak E, Pincetl S. Transpiration of urban forests in the Los Angeles metropolitan area. Ecological Applications. 2011 Apr 28;21(3):661–77.
22. Konarska J, Uddling J, Holmer B, Lutz M, Lindberg F, Pleijel H, et al. Transpiration of urban trees and its cooling effect in a high latitude city. Int J Biometeorol. 2016 Jan;60(1):159–72.
23. Xia F, Xing J, Xu J, Pan X. The short-term impact of air pollution on medical expenditures: Evidence from Beijing. Journal of Environmental Economics and Management. 2022 Jul;114:102680.
24. Ai H, Zhang X, Zhou Z. The impact of greenspace on air pollution: Empirical evidence from China. Ecological Indicators. 2023 Feb;146:109881.

25. Nowak DJ, McHale PJ, Ibarra M, Crane D, Stevens JC, Luley CJ. Modeling the Effects of Urban Vegetation on Air Pollution. In: Gryning SE, Chaumerliac N, editors. Air Pollution Modeling and Its Application XII [Internet]. Boston, MA: Springer US; 1998 [cited 2025 Jun 2]. p. 399–407. Available from: http://link.springer.com/10.1007/978-1-4757-9128-0_41
26. WHO. Noise [Internet]. 2011. Available from: https://www.who.int/europe/news-room/fact-sheets/item/noise
27. Rey-Gozalo G, Barrigón Morillas JM, Montes González D, Vílchez-Gómez R. Influence of Green Areas on the Urban Sound Environment. Curr Pollution Rep. 2023 Oct 26;9(4):746–59.
28. Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, et al. Auditory and non-auditory effects of noise on health. The Lancet. 2014 Apr;383(9925):1325–32.
29. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012 Dec;380(9859):2163–96.
30. Stansfeld SA, Matheson MP. Noise pollution: non-auditory effects on health. British Medical Bulletin. 2003 Dec 1;68(1):243–57.
31. UK Forest Research. Noise abatement [Internet]. Available from: https://www.forestresearch.gov.uk/tools-and-resources/fthr/urban-regeneration-and-greenspace-partnership/benefits-of-greenspace/noise-abatement/#:~:text=Greenspace%20has%20the%20ability%20to,human%20ear%20by%20approximately%2050%25.
32. Strachan DP. Hay fever, hygiene, and household size. BMJ. 1989 Nov 18;299(6710):1259–60.
33. Rook GAW. The old friends hypothesis: evolution, immunoregulation and essential microbial inputs. Front Allergy. 2023;4:1220481.
34. Von Hertzen L, Hanski I, Haahtela T. Natural immunity: Biodiversity loss and inflammatory diseases are two global megatrends that might be related. EMBO Reports. 2011 Nov;12(11):1089–93.
35. Selway CA, Mills JG, Weinstein P, Skelly C, Yadav S, Lowe A, et al. Transfer of environmental microbes to the skin and respiratory tract of humans after urban green space exposure. Environment International. 2020 Dec;145:106084.
36. Riedler J, Braun-Fahrländer C, Eder W, Schreuer M, Waser M, Maisch S, et al. Exposure to farming in early life and development of asthma and allergy: a cross-sectional survey. The Lancet. 2001 Oct;358(9288):1129–33.

37. MacNeill SJ, Sozanska B, Danielewicz H, Debinska A, Kosmeda A, Boznanski A, et al. Asthma and allergies: is the farming environment (still) protective in P oland? The GABRIEL Advanced Studies. Allergy. 2013 Jun;68(6):771–9.
38. Radon K, Windstetter D, Poluda AL, Mueller B, Mutius EV, Koletzko S, et al. Contact With Farm Animals in Early Life and Juvenile Inflammatory Bowel Disease: A Case-Control Study. Pediatrics. 2007 Aug 1;120(2):354–61.
39. Kaplan R, Kaplan S. The Experience of Nature. A Psychological Perspective. Cambridge University Press [Internet]. 1989; Available from: http://psichenatura.it/fileadmin/img/R._Kaplan__S._Kaplan_The_Experience_of_Nature__Introduction_.pdf
40. Ulrich RS. Aesthetic and Affective Response to Natural Environment. In: Altman I, Wohlwill JF, editors. Behavior and the Natural Environment [Internet]. Boston, MA: Springer US; 1983 [cited 2025 Jun 2]. p. 85–125. Available from: http://link.springer.com/10.1007/978-1-4613-3539-9_4
41. Valtchanov D, Ellard CG. Cognitive and affective responses to natural scenes: Effects of low level visual properties on preference, cognitive load and eye-movements. Journal of Environmental Psychology. 2015 Sep;43:184–95.
42. Liu L, Qu H, Ma Y, Wang K, Qu H. Restorative benefits of urban green space: Physiological, psychological restoration and eye movement analysis. Journal of Environmental Management. 2022 Jan;301:113930.
43. Liu Q sheng. A tasseled cap transformation for CBERS-04 fusion multispectral images. In: Jiang X, Hwang JN, editors. Eleventh International Conference on Digital Image Processing (ICDIP 2019) [Internet]. Guangzhou, China: SPIE; 2019 [cited 2025 Jun 2]. p. 39. Available from: https://www.spiedigitallibrary.org/conference-proceedings-of-spie/11179/2539649/A-tasseled-cap-transformation-for-CBERS-04-fusion-multispectral-images/10.1117/12.2539649.full
44. Janeczko E, Bielinis E, Wójcik R, Woźnicka M, Kędziora W, Łukowski A, et al. When Urban Environment Is Restorative: The Effect of Walking in Suburbs and Forests on Psychological and Physiological Relaxation of Young Polish Adults. Forests. 2020 May 24;11(5):591.
45. Wells NM, Rollings KA. The Natural Environment in Residential Settings: Influences on Human Health and Function. In: Clayton SD, editor. The Oxford Handbook of Environmental and Conservation Psychology [Internet]. 1st ed. Oxford University Press; 2012 [cited 2025 Jun 2]. p. 509–24. Available from: https://academic.oup.com/edited-volume/36322/chapter/318675863

46. Bowler DE, Buyung-Ali LM, Knight TM, Pullin AS. A systematic review of evidence for the added benefits to health of exposure to natural environments. BMC Public Health. 2010 Dec;10(1):456.
47. Pietilä M, Neuvonen M, Borodulin K, Korpela K, Sievänen T, Tyrväinen L. Relationships between exposure to urban green spaces, physical activity and self-rated health. Journal of Outdoor Recreation and Tourism. 2015 Jul;10:44–54.
48. De Jong K, Albin M, Skärbäck E, Grahn P, Björk J. Perceived green qualities were associated with neighborhood satisfaction, physical activity, and general health: Results from a cross-sectional study in suburban and rural Scania, southern Sweden. Health & Place. 2012 Nov;18(6):1374–80.
49. Roe J, Layla M. Restorative Cities. Urban Designing for Mental Health and Wellbeing. Great Britain: Bloomsbury visual Arts; 2021.
50. Zhang L, Zhou S, Kwan MP, Chen F, Lin R. Impacts of Individual Daily Greenspace Exposure on Health Based on Individual Activity Space and Structural Equation Modeling. IJERPH. 2018 Oct 22;15(10):2323.
51. Huang W, Lin G. The relationship between urban green space and social health of individuals: A scoping review. Urban Forestry & Urban Greening. 2023 Jul;85:127969.
52. Luo W, Chen C, Li H, Hou Y, Xia Y, Liu J, et al. Residential open space and the perception of health benefits: How much is the public willing to pay? Journal of Environmental Management. 2022 Aug;316:115273.
53. Li H, Luo W, Hou Y, Xia Y, Yao J, Kang N, et al. Factors Affecting Perceived Health Benefits and Use Behaviors in Urban Green Spaces During the COVID-19 Pandemic in Southern China Megacities. Front Public Health. 2021 Oct 28;9:759444.
54. Oh RRY, Zhang Y, Nghiem LTP, Chang C chen, Tan CLY, Quazi SA, et al. Connection to nature and time spent in gardens predicts social cohesion. Urban Forestry & Urban Greening. 2022 Aug;74:127655.
55. Capaldi C, Passmore HA, Nisbet E, Zelenski J, Dopko R. Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. Intnl J Wellbeing. 2015 Dec 17;5(4):1–16.
56. Davis N, Gatersleben B. Transcendent Experiences in Wild and Manicured Settings: The Influence of the Trait “Connectedness to Nature”. Ecopsychology. 2013 Jun;5(2):92–102.
57. Curtin S. Wildlife tourism: the intangible, psychological benefits of human–wildlife encounters. Current Issues in Tourism. 2009 Nov;12(5–6):451–74.
58. Fuller RA, Irvine KN, Devine-Wright P, Warren PH, Gaston KJ. Psychological benefits of greenspace increase with biodiversity. Biol Lett. 2007 Aug 22;3(4):390–4.

59. Ives CD, Giusti M, Fischer J, Abson DJ, Klaniecki K, Dorninger C, et al. Human–nature connection: a multidisciplinary review. Current Opinion in Environmental Sustainability. 2017 Jun;26–27:106–13.
60. Manzo A, Chesi C. Building Techniques and Structural Damage of Historical Constructions Detected Through the Point Cloud Survey. In: Aguilar R, Torrealva D, Moreira S, Pando MA, Ramos LF, editors. Structural Analysis of Historical Constructions [Internet]. Cham: Springer International Publishing; 2019 [cited 2025 Jun 2]. p. 135–43. (RILEM Bookseries; vol. 18). Available from: http://link.springer.com/10.1007/978-3-319-99441-3_13
61. Knez I, Ode Sang Å, Gunnarsson B, Hedblom M. Wellbeing in Urban Greenery: The Role of Naturalness and Place Identity. Front Psychol. 2018 Apr 11;9:491.
62. World Health Organisation. Adolescent Health [Internet]. Available from: https://www.who.int/health-topics/adolescent-health#tab=tab_1
63. Rice D, Barone S. Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. Environ Health Perspect. 2000 Jun;108(suppl 3):511–33.
64. Committee on the Neurobiological and Socio-behavioral Science of Adolescent Development and Its Applications, Board on Children, Youth, and Families, Division of Behavioral and Social Sciences and Education, Health and Medicine Division, National Academies of Sciences, Engineering, and Medicine. The Promise of Adolescence: Realizing Opportunity for All Youth [Internet]. Bonnie RJ, Backes EP, editors. Washington, D.C.: National Academies Press; 2019 [cited 2025 May 11]. Available from: https://www.nap.edu/catalog/25388
65. Crone EA, Dahl RE. Understanding adolescence as a period of social–affective engagement and goal flexibility. Nat Rev Neurosci. 2012 Sep;13(9):636–50.
66. Larsen B, Luna B. Adolescence as a neurobiological critical period for the development of higher-order cognition. Neuroscience & Biobehavioral Reviews. 2018 Nov;94:179–95.
67. Ye T, Yu P, Wen B, Yang Z, Huang W, Guo Y, et al. Greenspace and health outcomes in children and adolescents: A systematic review. Environmental Pollution. 2022 Dec;314:120193.
68. Sprague NL, Bancalari P, Karim W, Siddiq S. Growing up green: a systematic review of the influence of greenspace on youth development and health outcomes. J Expo Sci Environ Epidemiol. 2022 Sep;32(5):660–81.
69. Vella-Brodrick DA, Gilowska K. Effects of Nature (Greenspace) on Cognitive Functioning in School Children and Adolescents: a Systematic Review. Educ Psychol Rev. 2022 Sep;34(3):1217–54.

70. Taylor L, Hochuli DF. Defining greenspace: Multiple uses across multiple disciplines. Landscape and Urban Planning. 2017 Feb;158:25–38.
71. UK Forest Research. Types of Green Spave [Internet]. Available from: https://www.forestresearch.gov.uk/tools-and-resources/fthr/urban-regeneration-and-greenspace-partnership/types-of-greenspace/
72. Nor ANM, Abdullah SA. Developing Urban Green Space Classification System Using Multi-Criteria: The Case of Kuala Lumpur City, Malaysia. Journal of Landscape Ecology. 2019 May 1;12(1):16–36.
73. Urban Rambles. The different types of urban green spaces [Internet]. 2016. Available from: https://urbanrambles.org/background/the-different-types-of-urban-green-spaces-1333
74. Zhao J, Ouyang Z, Zheng H, Zhou W, Wang X, Xu W, et al. Plant species composition in green spaces within the built-up areas of Beijing, China. Plant Ecol. 2010 Aug;209(2):189–204.
75. Ranjha S. Maintenance of Neighborhood Parks: Perspectives from Resident Welfare Associations in East Delhi, India. Technische Universität Dresden; 2018.
76. Ju Y, Dronova I, Ma Q, Lin J, Moran MR, Gouveia N, et al. Assessing Normalized Difference Vegetation Index as a proxy of urban greenspace exposure. Urban Forestry & Urban Greening. 2024 Sep;99:128454.
77. Biswas SS. ChatGPT for Research and Publication: A Step-by-Step Guide. J Pediatr Pharmacol Ther. 2023;28(6):576–84.
78. on behalf of the GrandStand, Safe Step and Teenage Girls on the Move Research Groups, Leask CF, Sandlund M, Skelton DA, Altenburg TM, Cardon G, et al. Framework, principles and recommendations for utilising participatory methodologies in the co-creation and evaluation of public health interventions. Res Involv Engagem. 2019 Dec;5(1):2.
79. Bevan Jones R, Stallard P, Agha SS, Rice S, Werner-Seidler A, Stasiak K, et al. Practitioner review: Co-design of digital mental health technologies with children and young people. Child Psychology Psychiatry. 2020 Aug;61(8):928–40.
80. Verloigne M, Altenburg T, Chinapaw M, Chastin S, Cardon G, De Bourdeaudhuij I. Using a Co-Creational Approach to Develop, Implement and Evaluate an Intervention to Promote Physical Activity in Adolescent Girls from Vocational and Technical Schools: A Case Control Study. IJERPH. 2017 Aug 1;14(8):862.
81. Prins RG, Oenema A, Van Der Horst K, Brug J. Objective and perceived availability of physical activity opportunities: differences in associations with physical activity behavior among urban adolescents. Int J Behav Nutr Phys Act. 2009;6(1):70.

82. Dadvand P, Nieuwenhuijsen MJ, Esnaola M, Forns J, Basagaña X, Alvarez-Pedrerol M, et al. Green spaces and cognitive development in primary schoolchildren. Proc Natl Acad Sci USA. 2015 Jun 30;112(26):7937–42.

Appendix

Table of Contents

Appendix I - Questionnaire

Section A – Demographic Details

1.1 Your Age

1.2 Your Sex

- Male
- Female
- Non Binary
- Prefer not to Say

1.3. Your Education Level _____ (for example: 5th grade)

2. Location of Residence _____ (commune)
2.1 If more than one primary residence, other residence: _____ (commune)

Time spent in each of the residences on average per month
Time spent in the residence 1: _____ days per month
Time spent in the residence 2: _____ days per month

3. Location of School_____ (commune)

3.1 Do you live in boarding school
- Yes
- No

3.2 If yes, are you
- Full time boarder
- Weekly Boarder

Section B - Travel to School

4. How do you usually travel to school?
   Choose all that applies
   - Walk
   - Bicycle
   - Monocycle
   - Skate
   - Scooter / Electric Scooter
   - Car (with family or someone else)
   - Bus
   - Metro
   - Train

5. On your way to school, do you see any green spaces?
   - Yes
   - No

6. On your way to school, do you travel through a green space?
- Yes
- No

7. On a scale of 1-10, how green is your path to school? (1 is no green -10 the whole way is green)
   _____

Section C - Private Garden

8. Do you have a private garden in your home
- Yes
- No

9. If yes, do you spend time in your private garden
- Yes
- No

10. If yes, on average how much time do you spend on average in your private garden, when the weather is pleasant?
- Days per week. _____
- Minutes per Day _____

10. 1 What is your main activity in the private garden
- Free playing (ex. running around / chasing games / playing with a ball)
- Sports or Exercise
- Spending time with Pets
- Hanging out with friends or family
- Hobbies
- Gardening
- Relaxing
- Something else _____

Section D - Public Green Spaces

"Following questions are referring exclusively to public green spaces"

11. In the past month, which of these green spaces do you usually visit?
(Check all that apply)
    - Urban parks / Gardens / Squares
    - Forests / Woods
    - Green Trails / Pathways
    - Open Grassy Fields
    - Playgrounds
    - School grounds with green
    - Outdoor Sports fields (Skate parks, tennis/football/volleyball courts)
    - Religious places with green (Churches, cemeteries)
    - Other (please specify)

12. What are the types of two green spaces you visited most where you spent at least 15 mins, in the last three months

- Green Space 1:
    - Urban parks / Gardens / Squares
    - Forests / Woods
    - Green Trails / Pathways
    - Open Grassy Fields
    - Playgrounds
    - School grounds with green
    - Outdoor Sports fields (Skate parks, tennis/football/volleyball courts)
    - Religious places with green (Churches, cemeteries)
    - Other (please specify)

- Green Space 2:
    - Urban parks / Gardens / Squares
    - Forests / Woods
    - Green Trails / Pathways
    - Open Grassy Fields
    - Playgrounds

- School grounds with green
- Outdoor Sports fields (Skate parks, tennis/football/volleyball courts)
- Religious places with green (Churches, cemeteries)
- Other (please specify)

_____

Section E - Green Space 1

The following questions relate exclusively to green space 1

Green Space 1: _____

13. What do you usually do there?
    (Choose all that apply)
    - Organized sports or Physical activity (running/football/ physical education)
    - Active Playing (playing football / volleyball)
    - Pet Walking
    - Gardening
    - Strolling or Walking
    - Hunting / Fishing
    - Geocatching
    - Attend events (communal events)
    - Community/family gatherings (picnics, markets, etc.)
    - Meeting friends / Meeting Romantic partner
    - Leisure Playing (playing cards, board games)
    - Leisure (reading / painting / relaxing / listening to music)
    - Other _____

14. How often do you go to this green space
    - At least 5 times a week
    - 3–4 times a week
    - 1–2 times a week
    - 1–3 times a month
    - Less than once a month
    - Never

15. When do you usually go to this green space
    (Choose all that apply)
    - Weekday during school period
    - Weekend during school period
    - During Holidays

16. At which moment of the day do you usually go to this green space
    (Choose all that apply)
    - morning
    - afternoon
    - evening
    - night

---

17. How do you get to the green space? (Mode of Transport)
    - Walk
    - Bicycle
    - Monocycle
    - Skate
    - Scooter / Electric Scooter
    - Car (with family or someone else)
    - Bus
    - Metro
    - Train

18. How long does it take for you to get there?
    - Less than 5 minutes
    - 5-15 minutes
    - 15-30 mins
    - 30-60 minutes
    - More than one hour
    - Don't know

19. What do you usually do there?
    (Choose all that apply)
    - Organized sports or Physical activity (running/football/ physical education)
    - Active Playing (playing football / volleyball)
    - Pet Walking
    - Gardening
    - Strolling or Walking
    - Hunting / Fishing
    - Geocatching
    - Attend events (communal events)
    - Community/family gatherings (picnics, markets, etc.)
    - Meeting friends / Meeting Romantic partner
    - Leisure Playing (playing cards, board games)
    - Leisure (reading / painting / relaxing / listening to music)
    - Other _____

If your green space is urban park / playground / schoolground / sports field, answer questions from 20 to 28. If not, go to question 32.

20. Are there places to sit (park chairs, benches, tables, barriers, rocks)? (Yes / No)
    - Yes
    - No

21. Is there any shaded area to protect from rain? (Yes / No)
    - Yes
    - No

22. Is there any shaded area to protect from heat? (Yes / No)
    - Yes
    - No

23. Are you able to buy food in or near the green space? (Yes / No)
    - Yes
    - No

24. Are there any sports facilities or open-air gyms? (Yes / No)
    - Yes
    - No

25. Are there toilettes? (Yes / No)
    - Yes
    - No

26. Are you able to find drinking water? (Yes/No/I don't know)
    - Yes
    - No
    - I don’t know

27. Are you aware if the green space is disability accessible? (Yes / No/ I don’t know)
    - Yes

- No
- I don't know

28. Are there lakes or bodies of water in or near the green space? (Yes / No)
- Yes
- No

If your green spaces is a sports field, answer questions from 29 to 30, and then go to question to 33. If not go to question 31.

29. Do you have a storage facility for your belongings or equipment?
    - Yes
    - No

30. Do you have shower facilities?
    - Yes
    - No

If your green space is an urban park answer question 31 and then go to question 33. If not, go to question 32.

31. What do you like to have in this Green Space
    (Choose all that apply)
    - Quiet space
    - Benches
    - Area to play
    - Area to practice sports
    - Shaded areas
    - Access to toilettes
    - Access to drinking water
    - Artificial Lighting
    - Nothing else is needed

---

*If your green space is a **forest, answer** question **32**. If not, go to question 33.*

32. What do you like to have in this Green Space
    (Choose all that apply)
    - Places to sit
    - Areas to eat
    - Area or Trails to practice sports
    - Access to toilettes
    - Access to drinking water
    - Artificial Lighting
    - Nothing else is needed

Please answer all questions from question 33.

33. What are some of your difficulties in Accessing in this Green Space
    (Choose all that apply)
    - Mobility issues (e.g., disability-friendly or not)
    - Safety / security concerns
    - Distance
    - Time of opening / closing
    - Lack of signage to find it
    - No internet / phone access
    - Other (please specify)
    - None

34. How would you rate the green space overall? (1-4)
    - 1- Excellent
    - 2- Good
    - 3- Poor
    - 4- Very poor

35. How safe do you feel there? (1-4)
    - 1- Very safe
    - 2- Safe
    - 3- Unsafe
    - 4- Very unsafe

36. Do you feel the air is fresh / clean in this green space? (Scale 1–4)
    - 1- Very Fresh / Clean
    - 2- Somewhat Fresh / Clean
    - 3- Not very Fresh / Clean
    - 4- Very Unclean

37. How quiet is this green space? (Scale 1–4)
    - 1- Very quiet that I can hear natural sounds (leaves rustling or mosquitos buzzing)
    - 2- Quiet enough to hear minimal background noise (moderate rainfall or occasional conversations)
    - 3- Noisy as I can hear frequent and clearly audible human activities (group conversations, laughter, sports games)
    - 4- Very noisy as I can hear constant loud sounds (heavy traffic, construction work or crowded events)

38. Do you have a feeling of freedom in the green space? (Scale 1–4)
    - 1- Completely free
    - 2- Somewhat Free
    - 3- Not very free
    - 4- Not free

39. Is it comfortable or convenient to make new friends there? (scale 1-4)
    - 1- Can make new friends easily
    - 2- Can make new friends
    - 3- Hard to make new friends
    - 4- Impossible to make new friends

40. When it’s dark outside, do you have enough light to see clearly in the green space? (Scale 1–4)
    - 1- Enough light to read
    - 2- Enough light to see the pathway
    - 3- Barely enough light to see the pathway
    - 4- Not enough light at all

41. Can you smell the scent of flowers, when it’s springtime? (Scale 1–4)
    - 1- Can easily smell the scent of flowers
    - 2- I must lean in to smell the scent of flowers
    - 3- Barely able to get the smell the scent of flowers
    - 4- No smell at all

42. Do you hear cars or construction noise usually, in the distance? (Scale 1–4)
    - 1- I can hear a lot of noise
    - 2- Some noise of cars or construction is heard
    - 3- Very little noise of cars or construction is heard
    - 4- No noise at all

43. Do you find that the green space is colder than in the streets? (Scale 1–4)
    - 1- Clearly colder than in the streets

- 2- Somewhat colder than in the streets
- 3- Barely colder than in the streets
- 4- Same as the streets

44. How do you find the view of this green space? (Scale 1–4)
    - 1- Much more beautiful
    - 2- Somewhat beautiful
    - 3- Not very beautiful
    - 4- Not beautiful at all

45. Can you hear birds chirping? (Scale 1–4)
    - 1- I can hear the birds clearly
    - 2- I can somewhat hear the birds
    - 3- Barely able to hear the birds
    - 4- Cannot hear the birds at all

46. Are you allergic to any pollen in this green space? (Yes/No/I don't know)
    - Yes
    - No
    - I don’t know

46.1 If yes, name them (optional question) _____

46.2 If yes, do you have more allergic symptoms when you visit this green spaces
- Yes
- No
- I don’t know

47. Is it comfortable or convenient to meet friends there? (scale 1-4)
    - 1- Can meet my friends very easily
    - 2- Can meet my friends somewhat easily
    - 3- Somewhat difficult to meet my friends
    - 4- Impossible to meet my friends

48. Do the green space pathways have lamps for you to walk in the dark? (Scale 1–4)?
    - 5- Enough lamp light to find your way easily
    - 6- Enough lamp light to somewhat find your way
    - 7- Barely enough lamp light to see the pathway
    - 8- No lamps at all

49. Do you think the greenspace is well suited for everyone?
    - Yes
    - No

49.1 If no, Why? _____

50. Do you have the opportunity to see domesticated animals like Cows and Donkeys (Yes/No/I don't know)
- Yes
- No
- I don’t know

51. Do you have the opportunity to see wild (cute) fauna like foxes, deer’s, butterflies? (Yes/No/I don't know)
- Yes
- No
- I don’t know

52. Does it become muddy after rain? (Yes/No/I don't know)
- Yes
- No

- I don't know

53. Have you seen any of these [Observed Problems in Green Spaces]
    (Check all that apply)
    - Litter
    - Vandalism
    - Evidence of drug use
    - Tobacco Consumption
    - Consumption of alcohol
    - Violence
    - Nuisance /Harmful Fauna (Rats, Insects, Mosquitoes etc.)
    - Other (please specify)
    - None

54. What are you most satisfied with in this green space _____

55. What are you most dissatisfied with in this green space _____

Section E - Green Space 2

The following questions relate exclusively to green space 2

Green Space 2: _____

13. What do you usually do there?
    (Choose all that apply)
    - Organized sports or Physical activity (running/football/ physical education)
    - Active Playing (playing football / volleyball)
    - Pet Walking
    - Gardening
    - Strolling or Walking
    - Hunting / Fishing
    - Geocatching
    - Attend events (communal events)
    - Community/family gatherings (picnics, markets, etc.)
    - Meeting friends / Meeting Romantic partner
    - Leisure Playing (playing cards, board games)
    - Leisure (reading / painting / relaxing / listening to music)
    - Other _____

14. How often do you go to this green space
    - At least 5 times a week
    - 3–4 times a week
    - 1–2 times a week
    - 1–3 times a month
    - Less than once a month
    - Never

15. When do you usually go to this green space
    (Choose all that apply)
    - Weekday during school period
    - Weekend during school period
    - During Holidays

16. At which moment of the day do you usually go to this green space
    (Choose all that apply)
    - morning
    - afternoon
    - evening
    - night

---

17. How do you get to the green space? (Mode of Transport)
    - Walk
    - Bicycle
    - Monocycle
    - Skate
    - Scooter / Electric Scooter
    - Car (with family or someone else)
    - Bus
    - Metro
    - Train

18. How long does it take for you to get there?
    - Less than 5 minutes
    - 5-15 minutes
    - 15-30 mins
    - 30-60 minutes
    - More than one hour
    - Don't know

19. What do you usually do there?
    (Choose all that apply)
    - Organized sports or Physical activity (running/football/ physical education)
    - Active Playing (playing football / volleyball)
    - Pet Walking
    - Gardening
    - Strolling or Walking
    - Hunting / Fishing
    - Geocatching
    - Attend events (communal events)
    - Community/family gatherings (picnics, markets, etc.)
    - Meeting friends / Meeting Romantic partner
    - Leisure Playing (playing cards, board games)
    - Leisure (reading / painting / relaxing / listening to music)
    - Other _____

If your green space is urban park / playground / schoolground / sports field, answer questions from 20 to 28. If not, go to question 32.

20. Are there places to sit (park chairs, benches, tables, barriers, rocks)? (Yes / No)
    - Yes
    - No

21. Is there any shaded area to protect from rain? (Yes / No)
    - Yes
    - No

22. Is there any shaded area to protect from heat? (Yes / No)
    - Yes
    - No

23. Are you able to buy food in or near the green space? (Yes / No)
    - Yes
    - No

24. Are there any sports facilities or open-air gyms? (Yes / No)
    - Yes

- No

25. Are there toilettes? (Yes / No)
- Yes
- No

26. Are you able to find drinking water? (Yes/No/I don't know)
- Yes
- No
- I don’t know

27. Are you aware if the green space is disability accessible? (Yes / No/ I don’t know)
- Yes
- No
- I don’t know

28. Are there lakes or bodies of water in or near the green space? (Yes / No)
- Yes
- No

If your green spaces is a sports field, answer questions from 29 to 30, and then go to question to 33. If not go to question 31.

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    - Area to practice sports
    - Shaded areas
    - Access to toilettes
    - Access to drinking water
    - Artificial Lighting
    - Nothing else is needed

---

*If your green space is a **forest, answer** question **32**. If not, go to question 33.*

32. What do you like to have in this Green Space
    (Choose all that apply)
    - Places to sit
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    - Access to drinking water
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Please answer all questions from question 33.

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(Choose all that apply)
    - Mobility issues (e.g., disability-friendly or not)
    - Safety / security concerns
    - Distance
    - Time of opening / closing
    - Lack of signage to find it
    - No internet / phone access
    - Other (please specify)
    - None

34. How would you rate the green space overall? (1-4)
    - 1- Excellent
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    - 1- Very quiet that I can hear natural sounds (leaves rustling or mosquitos buzzing)
    - 2- Quiet enough to hear minimal background noise (moderate rainfall or occasional conversations)
    - 3- Noisy as I can hear frequent and clearly audible human activities (group conversations, laughter, sports games)
    - 4- Very noisy as I can hear constant loud sounds (heavy traffic, construction work or crowded events)

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    - 1- Completely free
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    - 3- Not very free
    - 4- Not free

39. Is it comfortable or convenient to make new friends there? (scale 1-4)
    - 1- Can make new friends easily
    - 2- Can make new friends
    - 3- Hard to make new friends
    - 4- Impossible to make new friends

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    - 1- I can hear a lot of noise
    - 2- Some noise of cars or construction is heard
    - 3- Very little noise of cars or construction is heard
    - 4- No noise at all

43. Do you find that the green space is colder than in the streets? (Scale 1–4)
    - 1- Clearly colder than in the streets
    - 2- Somewhat colder than in the streets
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    - 1- Much more beautiful
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    - 1- I can hear the birds clearly
    - 2- I can somewhat hear the birds
    - 3- Barely able to hear the birds
    - 4- Cannot hear the birds at all

46. Are you allergic to any pollen in this green space? (Yes/No/I don't know)
    - Yes
    - No
    - I don’t know

46.3 If yes, name them (optional question) _____

46.4 If yes, do you have more allergic symptoms when you visit this green spaces
- Yes
- No
- I don’t know

47. Is it comfortable or convenient to meet friends there? (scale 1-4)
    - 1- Can meet my friends very easily
    - 2- Can meet my friends somewhat easily
    - 3- Somewhat difficult to meet my friends
    - 4- Impossible to meet my friends

48. Do the green space pathways have lamps for you to walk in the dark? (Scale 1–4)?
    - 5- Enough lamp light to find your way easily
    - 6- Enough lamp light to somewhat find your way
    - 7- Barely enough lamp light to see the pathway
    - 8- No lamps at all

49. Do you think the greenspace is well suited for everyone?
    - Yes
    - No

49.1 If no, Why? _____

50. Do you have the opportunity to see domesticated animals like Cows and Donkeys (Yes/No/I don't know)

- Yes
- No
- I don’t know

51. Do you have the opportunity to see wild (cute) fauna like foxes, deer’s, butterflies? (Yes/No/I don't know)

- Yes
- No
- I don’t know

52. Does it become muddy after rain? (Yes/No/I don't know)

- Yes
- No
- I don’t know

53. Have you seen any of these [Observed Problems in Green Spaces]
(Check all that apply)
    - Litter
    - Vandalism
    - Evidence of drug use
    - Tobacco Consumption
    - Consumption of alcohol
    - Violence
    - Nuisance /Harmful Fauna (Rats, Insects, Mosquitoes etc.)
    - Other (please specify)
    - None

54. What are you most satisfied with in this green space _____

55. What are you most dissatisfied with in this green space _____

Appendix II – Guide for Co-Creation with Adolescents Workshop

Time	Type of Activity	Description
5 mins	Introduction/ Ice breaker	Explain the project + “One word to describe your best outdoor space”
15 mins	Story Mapping	Day in life of the teenager in accessing the green space The teenager explains / write’s down how he accesses green spaces in paper/board - walks past every day / takes the dog for a walk in the park near the house… *Identifies routines
10 mins	Photo prompts	They will be shown photos of green spaces (forests, urban parks, sports fields, squares, abandoned lots, cemeteries) and be asked - Would you go there? Why/ not What should we ask about this space?
20 mins	Design your own questions challenge	In a group of 2’s / 3’s, they are asked to write down their own questions for each of the categories. - On accessibility, usage, safety etc. They pitch their favorite ones to the class *Reveals priorities and language they are comfortable with using
15 mins	Emoji + Voting	Each question will be rated with an emoji ☺ - good 😐 - okay ☹ - confusing For okay and confusing questions, they will be asked on how it can be framed better / or removed. Everyone votes for the most important section + question using dot stickers. *Reveals priorities
5 mins	Conclusion	Thank you and explain how these insights will be used

Appendix III – Guide for Focus Group Discussion

Time	Type of Activity	Description
5 mins	Introduction + Ice Breaker	Explain the project, use menti-meter to identify top priority in – use of green spaces for adolescents' health and well-being.
10 mins	Introduction to the questionnaire	Explain the questionnaire, the thought process to each section, type of questions... Preliminary inputs on demographic profile. (in case of standalone questionnaire)
10	Preliminary inputs	Ask them for preliminary inputs on section, missing constructs, and preliminary thoughts on questions.
45 mins (15mins x3)	Rotating Chairs	The focus group is divided into groups of 3 – each assigned to different tables. Each table contains 1 section (Usage/Services/Perceptions)- with a facilitator to a table. Each person then rotates between all 3 tables, changing intermittently for a period of 15 mins at each table, where they will provide expert inputs to each of the sections. Each facilitator – based on the section can employ different methods (Usage section – open-ended discussion on appropriate questions, barriers to honest reporting Services – use dot stickers or red/blue pen on whether they are needed/missing or can be framed better Perception- open-ended discussion on measurement clarity/ preferred metrics/ validated scales suggestions...)
15 mins	Priority Setting and Finalisation of Questions	Rapid group synthesis on what are "nice to have" and what are "non- negotiable" and what is "not needed". If we have a standalone questionnaire- what are the needed questions for demographic profile.
10 mins	Parent Questionnaire Discussion	Focus discussion for parents. - is it needed. Is it clear enough/ missing any questions. how much do parents know about the teenagers.
5 mins	Final Recommendation	Final comments and follow up information.

Appendix IV – AI Generated Questionnaire

Section 1: General Information

1. **Age**: ___ years
2. **Gender** (circle one): Male / Female / Non-binary / Prefer not to say
3. **School grade/year**: _____
4. **Postcode or neighborhood** (optional): _____

Section 2: Usage of Green Spaces

1. **How often do you visit parks or green spaces (like fields, forests, gardens)?**
   ☐ Every day
   ☐ A few times a week
   ☐ Once a week
   ☐ A few times a month
   ☐ Hardly ever
   ☐ Never
2. **How much time do you usually spend during each visit?**
   ☐ Less than 30 minutes
   ☐ 30 minutes to 1 hour
   ☐ 1 to 2 hours
   ☐ More than 2 hours
3. **Who do you usually go with?** (Check all that apply)
   ☐ By myself
   ☐ Friends
   ☐ Family
   ☐ School or youth group
   ☐ Other: _____
4. **What do you usually do in green spaces?** (Check all that apply)
   ☐ Walking
   ☐ Playing sports or games
   ☐ Sitting or relaxing
   ☐ Reading or studying
   ☐ Exploring nature
   ☐ Taking photos or videos
   ☐ Other: _____

Section 3: Available Services and Features

5. **What types of green spaces are near your home (within 15 minutes' walk)?** (Check all that apply)
   ☐ Public parks
   ☐ School playgrounds or fields
   ☐ Forests or woodlands
   ☐ Community gardens
   ☐ Rivers/lakes/ponds
   ☐ Sports fields or courts
   ☐ None nearby
6. **What features or facilities are available in the green spaces you visit?** (Check all that apply)
   ☐ Benches or seating

- ☐ Playgrounds
- ☐ Sports areas (e.g., basketball, soccer fields)
- ☐ Bike or walking paths
- ☐ Toilets
- ☐ Water fountains
- ☐ Picnic areas
- ☐ Trash bins
- ☐ Lighting
- ☐ Nature trails or wildlife areas
- ☐ Other: _____

7. **Are the green spaces near you easy to get to?**
   - ☐ Yes
   - ☐ No
   - ☐ Not sure

Section 4: Perception of Green Spaces

8. **How safe do you feel in green spaces near you?**
   - ☐ Very safe
   - ☐ Mostly safe
   - ☐ Sometimes unsafe
   - ☐ Often unsafe
   - ☐ I don't know
9. **How clean are the green spaces you go to?**
   - ☐ Very clean
   - ☐ Mostly clean
   - ☐ Sometimes dirty
   - ☐ Often dirty
   - ☐ I don't know
10. **Do you feel welcome in your local green spaces?**
    - ☐ Yes, always
    - ☐ Sometimes
    - ☐ Not really
    - ☐ Not at all
11. **Do you think spending time in green spaces is good for your health or mood?**
    - ☐ Yes, definitely
    - ☐ Maybe
    - ☐ Not really
    - ☐ No
12. **What do you like most about green spaces?** (Open-ended)

13. **What do you wish could be improved?** (Open-ended)

Section 5: Additional Comments (Optional)

14. Is there anything else you'd like to share about green spaces in your area?