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Integrating Child-Friendly Green Spaces into Post-Disaster Recovery: Psychological, Physical, and Educational Sustainability Impact on Children's Well-Being

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Abstract

This study reviews the role of Child-Friendly Green Spaces (CFGS) in supporting children's psychological, physical, and educational recovery following natural disasters. The main research question guiding this review is the following: how do CFGS contribute to holistic child well-being and resilience in disaster-affected contexts, and what barriers and strategies influence their effective integration into recovery frameworks? Employing a rigorous literature review methodology, we synthesized interdisciplinary evidence from environmental psychology, urban planning, public health, and education, encompassing studies published between 2000 and 2024. Findings demonstrate that CFGS significantly reduce trauma-related symptoms such as anxiety, depression, and post-traumatic stress, promotes physical health through active play, and foster educational engagement by improving concentration, attendance, and informal learning opportunities. Furthermore, CFGS contribute directly to multiple Sustainable Development Goals, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 11 (Sustainable Cities and Communities). Despite these advantages, CFGS are often overlooked in formal disaster recovery planning due to prioritization of immediate relief, financial and logistical challenges, and socio-cultural factors. To address these challenges, this study proposes a participatory, culturally sensitive framework for CFGS implementation, which integrates inclusive design, multi-sector collaboration, and ongoing monitoring and evaluation. Grounded in theoretical perspectives such as the Biophilia Hypothesis, Bronfenbrenner's Ecological Systems Theory, and restorative environments, CFGS are reframed as critical infrastructures for children's holistic recovery and resilience. The findings underscore the urgent need to embed CFGS within disaster recovery and urban planning policies to promote child-centered, sustainable community development.

Keywords: restorative environment; holistic post-disaster recovery; children's well-being; urban resilience; sustainable urban planning

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1. Introduction

Communities are severely impacted by natural catastrophes, with children particularly vulnerable due to their developmental stage [1,2]. Long-term hazards affect their physical health, psychological well-being, and educational attainment, underscoring the need for comprehensive, sustainable recovery plans [3]. Child-Friendly Green Spaces (CFGS) are becoming more widely acknowledged as useful but underutilized resources for recovery after a disaster. These multifunctional outdoor environments are thoughtfully designed to support children's

developmental needs by providing accessible, inclusive, and nature-based settings that foster play, learning, and social interaction [4,5]. Grounded in the Biophilia Hypothesis and Bronfenbrenner's Ecological Systems Theory, CFGS foster children's resilience by providing restorative settings that support emotional healing, social interaction, and cognitive development [6–8]. Empirical evidence shows that access to CFGS reduces trauma-related symptoms such as anxiety, depression, and post-traumatic stress disorder [9,10], while promoting physical activity essential for recovery [11,12]. Furthermore, CFGS enhance educational outcomes by improving concentration, school attendance, and informal learning opportunities [13,14].

Despite these benefits, CFGS are often marginalized in disaster recovery planning due to competing priorities, financial constraints, and socio-cultural barriers [15,16]. Building on these insights, we set up the primary research question guiding this study as follows: How do Child-Friendly Green Spaces support the multidimensional recovery of children affected by natural disasters? The objective is to synthesize interdisciplinary literature to elucidate the psychological, physical, and educational roles of CFGS in post-disaster recovery, identify barriers to their integration, and propose a participatory, culturally sensitive framework for sustainable implementation. This aligns with Sustainable Development Goals, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 11 (Sustainable Cities and Communities), underscoring CFGS as vital infrastructures for resilient, child-centered communities [17,18].

2. Materials and Methods

2.1. Search Strategy and Selection Criteria

We conducted a literature review to investigate the multifaceted role of CFGS in supporting children's recovery after natural disasters. This rigorous approach was selected for its capacity to synthesize interdisciplinary evidence from environmental psychology, urban planning, public health, and educational resilience, providing a comprehensive understanding of how CFGS address children's psychological, physical, and educational needs in disaster contexts [19–21]. The review was guided by predefined criteria, focusing on indicators such as mental health outcomes, access to educational resources, and social support networks [22]. The effectiveness of CFGS was evaluated using established criteria, including psychological well-being, health outcomes, and educational engagement [23], with key themes identified through thematic analysis [24]. Literature searches were conducted across Scopus, PubMed, Web of Science, and Google Scholar using a broad set of keywords such as "child-friendly green spaces," "disaster recovery," and "psychosocial support." Articles published between 2000 and 2024 were included, resulting in 819 identified articles. From these articles, the manual screening process was conducted to refine a final database for extraction. The selection process is illustrated in Figure 1.

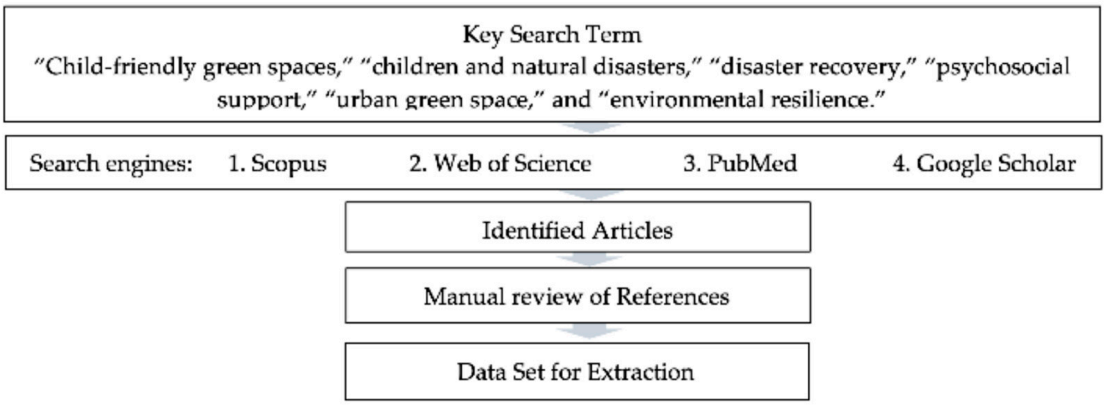

Figure 1. Article's search strategy.

2.2. Data Analysis and Synthesis

The data analysis for this review applied thematic analysis, a qualitative method well-suited for synthesizing interdisciplinary findings from environmental psychology, urban planning, public health, and education [25,26]. This approach enabled the identification of recurring patterns and key themes related to the psychological, physical, and educational benefits of Child-Friendly Green Spaces (CFGS) in post-disaster recovery contexts. Thematic analysis involved familiarization with the data set, initial coding, theme development, and synthesis. Articles were categorized according to vulnerability dimensions—psychological, physical, and educational—to ensure systematic integration and comprehensive coverage. From an initial pool of 75 full-text articles identified across major databases—Scopus (24), Web of Science (30), PubMed (11), and Google Scholar (10)—42 met the eligibility criteria for thematic analysis. After quality appraisal and thematic relevance assessment, 25 articles were included in the final synthesis, ensuring both breadth and depth of evidence [27,28]. The synthesis revealed interconnected benefits of CFGS, highlighting their role in fostering emotional stability, promoting physical health, and facilitating educational engagement among children affected by disasters. The synthesis incorporated the analysis of design features that influence user engagements, including accessibility, sensory affordances, and multifunctionality, as well as barriers to CFGS, thereby integrating policy gaps, financial constraints, and socio-cultural challenges, which must be addressed to optimize recovery outcomes [15,16,27,29]. The data analysis and synthesis are visually represented in Figure 2.

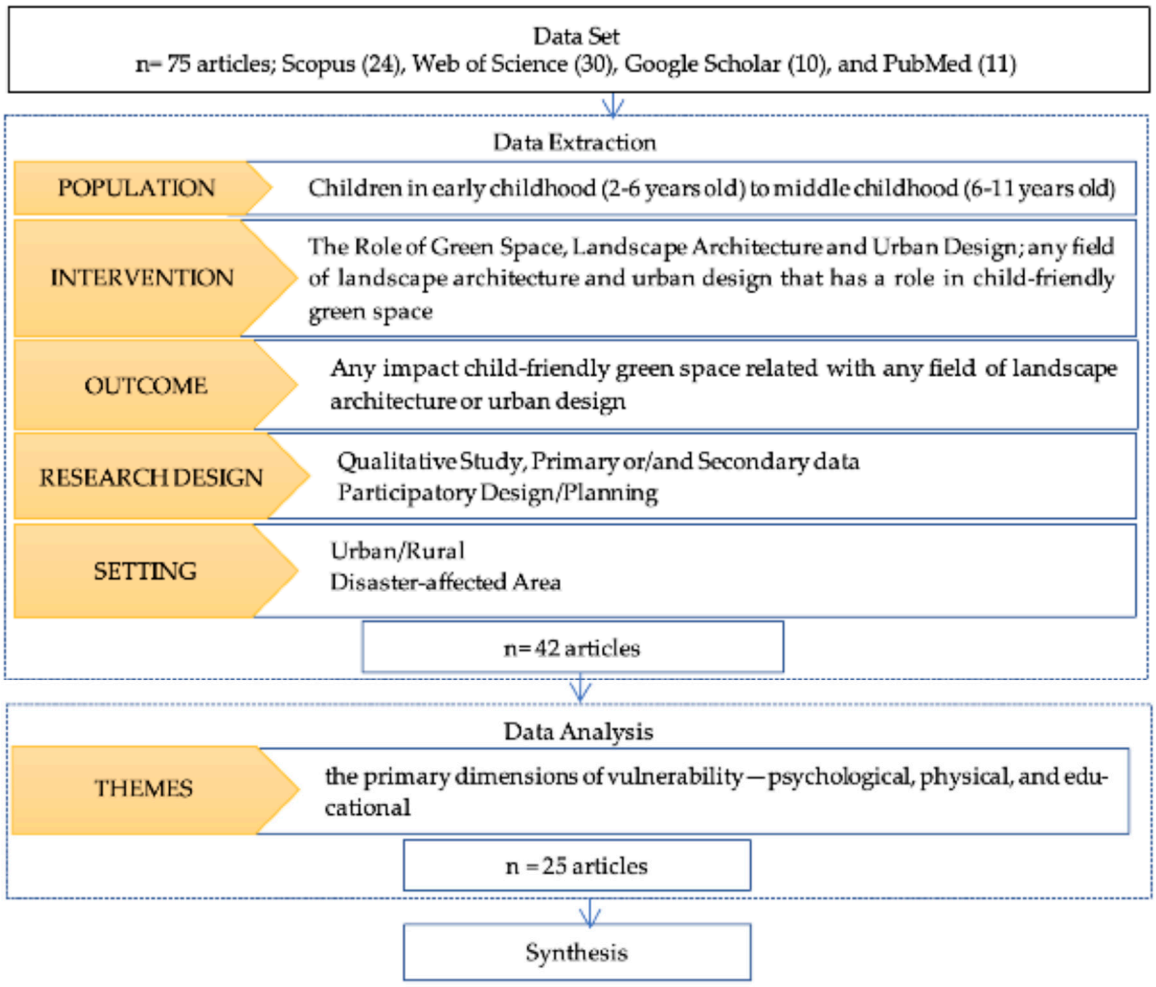

Figure 2. Data analysis and synthesis illustrate the steps of thematic analysis, from initial coding of literature to the identification of major themes related to psychological, physical, and educational recovery.

3. Results

3.1. Definitions and Characteristics

CFGS are outdoor spaces designed to meet children's developmental needs by providing safe, accessible, and stimulating natural settings [4,5]. These areas remain beyond basic green spaces by incorporating various components that encourage play, learning, and social interaction, while remaining culturally sensitive and adapted to the local environment [18,30]. CFGS includes parks, playgrounds, gardens, and natural reserves, which are all designed to support children's growth mentally, physically, emotionally, and socially [31].

The reviews emphasized how important it is to incorporate significant contributions by Hussein and Din et al., which offer a lot of sensory and healing stimulation that helps children learn and interact with others, especially those with special needs [27,28]. The gardens use sound, touch, scent, and sight to foster involvement, communication, and better behaviors. This shows how CFGS can be used for therapy and education. Accessibility is a key component of CFGS; it ensures that everybody can safely and easily access the site. Another important feature is multifunctionality, indicating that there are both structured and unstructured play areas for children of all ages and abilities [5,16]. Emotional connection is critically important. CFGS gives children a sense of belonging, comfort, and safety, which is particularly significant for children who are recovering from trauma [10,32].

Safety issues require that children with disabilities can utilize the design, which lowers risks while promoting exploration [33,34]. Children's senses and brains grow when they are around natural things like different plants, water features, and animals. When the community helps design and take care of CFGS, it builds ownership, relevance, and sustainability, making sure that these spaces really meet the needs of children and families. Based on the review, the characteristics of Child-Friendly Green Spaces (CFGS) are explained in Table 1.

Table 1. CFGS characteristic.

Characteristic	Key Features	Benefits	References
Accessibility	Within walking distance, inclusive design. Combines structured/unstructured areas.	Reduces health inequalities	[5,28,35,36]
Multifunctionality	Diverse experiences and activities tailored to the local cultural and environmental context	Support holistic development (physical, emotional, social, intellectual, and cognitive development)	[18,30,35]
Emotional Connection	Foster connection to nature, sense of belonging, and nurtures spiritual growth and empathy.	Encourages positive feelings, comfort, empathy, and resilience in children	[5,10,18,28]
Safety	Secure environment; minimized risks; inclusive for children with disabilities	Enables safe exploration and play; increases parental and community trust	[5,33,34]
Natural elements	Biodiversity (Variety of plants, trees, water features, wildlife)	Enhances sensory stimulation, supports cognitive restoration, and stewardship of nature	[5,37,38]
Community Participation	Involvement of children, family, stakeholders, and local community in the design and maintenance of green space	Ensures spaces meet children's needs, build community ownership, and promote stewardship	[5,16,28]

3.2. Theoretical Foundations and Practical Outcome

The framework integrates four key theories: the Biophilia Hypothesis, Bronfenbrenner's Ecological Systems Theory, the concept of Restorative Environments, and Healing Environments with Multi-sensory stimulation. The Biophilia Hypothesis posits that humans have an innate affinity for nature, which enhances psychological well-being, resilience, and recovery [7,27,39]. Empirical studies demonstrate that children's interaction with natural environments reduces anxiety and stress, fostering improved coping skills essential for trauma recovery [6]. This intrinsic connection to nature supports emotional regulation and promotes mental health benefits critical in post-disaster healing. Bronfenbrenner's Ecological Systems Theory emphasizes the importance of stable and supportive microsystems in child development [8]. CFGS serve as these nurturing microsystems by providing safe, engaging spaces that foster emotional and

social growth [40]. These environments enable children to rebuild disrupted social ties and regain a sense of normalcy, which is vital for their overall recovery and well-being.

The Restorative Environment concept enriches this framework by highlighting the role of nature-inclusive spaces in facilitating cognitive and emotional restoration through a three-stage model: containment, passive restoration, and active restoration [16,37,41]. CFGS offer a balance of quiet reflection areas and active play zones, catering to diverse recovery needs and promoting holistic healing processes. Furthermore, healing Environments focus on enhancing engagement, social interaction, and emotional well-being, particularly for children with special needs [27,29,35,38]. These environments incorporate varied sensory stimuli that support children's educational, physical, and psychological development, addressing vulnerabilities comprehensively [1]. Together, these theoretical foundations inform the sustainable design and implementation of CFGS, resulting in practical outcomes that include immediate psychological recovery, long-term well-being, community involvement, and the promotion of resilience.

CFGS are characterized by accessibility, multifunctionality, emotional connection, and safety, integrating natural elements such as plants, water features, and biodiversity to foster children's affinity for nature while ensuring secure environments [5,18,30,33,34,36,37]. CFGS address children's multidimensional vulnerabilities in the post-disaster context by providing inclusive, nature-based environments that support physical activity, social interaction, cognitive development, and emotional healing. Additionally, it addresses the historical invisibility of children in urban design by centering their needs and perspectives, reshaping urban dynamics toward equity and inclusivity. Participatory approaches involving children enhance the relevance and sustainability of these spaces [16,18]. This holistic approach ensures that CFGS function not merely as recreational areas but as vital infrastructures that nurture children's recovery and resilience sustainably. The conceptual framework integrating these theoretical foundations with practical outcomes is visually presented in Figure 3, underscoring the synergy between innate human-nature connections, ecological support, restorative experiences, and healing environment to highlight their role in addressing children's vulnerabilities and fostering holistic recovery after disasters.

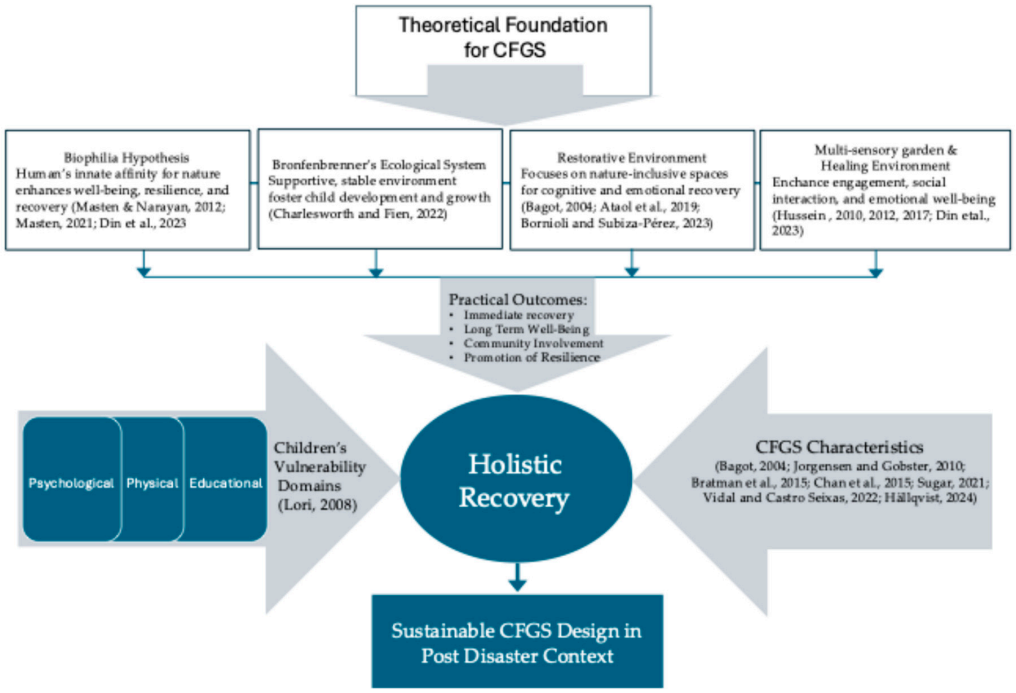

Figure 3. Theoretical foundations and practical outcomes of CFGS framework. This conceptual model summarizes the integration of biophilia hypothesis [7,27,39], ecological systems theory [8], restorative

environments [16,37,41], and multi-sensory garden and healing environment [27,29,35,38]. It also incorporates children's vulnerability domains [1], and highlight CFGS characteristics promoting sustainable design for holistic recovery [5,18,30,33,34,36,37].

3.3. The Role of Play and Landscape in Post-Disaster Recovery

Play and landscape design are highly important for helping children recover after disasters. Play is essential for children's healing after disaster, enabling trauma processing, social reconnection, and return to normal routines [42,43]. Child-Friendly Green Spaces (CFGS) that include play areas create safe [44], fun places that support children build emotional strength, make friends, and learn new things [4,5]. Studies emphasize the importance of unstructured outdoor play in natural settings for reducing stress and rebuilding confidence [45,46]. Children can learn to be independent, confident, and control their emotions in secure places like playgrounds and natural play areas [44,47]. For instance, the playgrounds in New Orleans after Hurricane Katrina served dual roles as play spaces and community hubs, facilitating collective healing and social cohesion [9,30]. Similarly, UNICEF's child-friendly spaces following the 2010 Haiti earthquake provided structured and unstructured play opportunities that supported children's emotional and educational recovery [48].

Integrating natural elements like gardens, trees, and water features to play areas makes them more healing by making them more relaxing and lowering tension and anxiety [27,31,41]. Healing gardens and multi-sensory play places with lots of things to touch, hear, and see are great for children with special needs because they help with sensory engagement, social connection, and learning [28,29,35,38]. These settings promote exploration, creativity, and socializing with peers, all of which are important for emotional intelligence and cognitive recovery [40,49,50].

Nature-based play areas are good for both mental and physical health. They encourage vigorous play, which is good for your heart, muscles, and general health [12,51]. Studies show that children with regular access to green play spaces exhibit lower obesity risk and better physical health outcomes, contributing to sustained well-being [52,53]. Children's social, critical thinking, and problem-solving abilities are all enhanced when they play freely in natural settings, and these abilities are crucial for a full recovery following a disaster [40,50]. CFGS are places that help people heal by giving them both passive restorations, like calm reflection and connection with nature, and active restorations, like play and social interaction [6,41]. These two restorative activities meet a variety of healing requirements, giving children safe places to deal with trauma and become stronger.

Play landscapes should be designed with cultural sensitivity and participation in mind, so that children and communities may be included in the process and feel like they own it [16,54]. This method helps communities stay together and thrive. For example, the successful rehabilitation of City Park in New Orleans, where play areas that included nature helped both individuals and the city heal [15,55]. Play and landscape architecture are essential for children's post-disaster recovery, supporting emotional healing, physical health, cognitive development, and social cohesion. In the future, disaster recovery planning should put a high priority on including nature-based play areas since they are very important for helping children who have been through a disaster become more resilient and healthier.

3.4. Green Space for Children's Recovery Post-Natural Disaster

Child-Friendly Green Spaces (CFGS) serve as vital recovery environments that holistically support children's psychological, physical, and educational well-being following natural disasters. The literature affirms that CFGS extends beyond recreational functions, providing therapeutic, developmental, and resilience-building benefits essential for sustainable recovery [7,30,41,56].

1. Psychological Impact

Access to CFGS significantly mitigates trauma-related psychological distress in children exposed to disasters. Studies consistently report reductions in anxiety, depression, and post-traumatic stress symptoms among children engaging with natural environments [9,10,52]. Nature-based settings provide restorative experiences that foster emotional stability, stress reduction, and a sense of safety and normalcy critical for trauma recovery [34,57–59]. Structured and unstructured play within CFGS further facilitates trauma processing, happiness, and social support, reinforcing emotional resilience [10,54]. Healing environments designed with therapeutic elements—such as safe spaces, personal control, and natural stimuli—enhance recovery outcomes [27,31]. Sensory gardens and multi-sensory play areas, especially for children with special needs, provide critical stimuli that support emotional and cognitive healing [28,29,35,38]. These spaces contribute to social interaction, emotional expression, and behavioral improvements, underscoring the importance of inclusive, sensory-rich design in recovery contexts.

2. Physical Health Benefits

CFGS encourages physical activity, which is indispensable for children's physical recovery and overall health post-disaster. Outdoor play in green spaces improves cardiovascular fitness, muscle strength, and mood, helping counteract the physical and psychological toll of trauma [11,60–62]. Empirical evidence reveals that children with regular access to CFGS exhibit better attention, reduced obesity risk, and healthier habits [52,53,63,64]. Nature exposure also promotes healthy lifestyle development, encouraging active play and social engagement that contribute to long-term well-being [12,51]. The physical affordances of CFGS, including accessible pathways and varied natural features, support mobility and sustained engagement, particularly for children with disabilities [28]. These physical benefits are integral to holistic recovery, enabling children to regain strength and resilience.

3. Educational Impact

Educational recovery is a crucial dimension supported by CFGS, which fosters cognitive development, school attendance, and academic performance. Access to green spaces reduces stress and improves concentration, memory, and executive functioning, thereby enhancing children's ability to learn effectively post-disaster [13,14,17,65,66]. Natural and multifunctional green spaces provide informal learning environments that encourage creativity, exploration, and social skills development—key to academic success and personal growth [47,67,68]. Environmental education programs within CFGS have demonstrated sustained improvements in critical thinking, environmental awareness, and stewardship, reinforcing their role in long-term educational recovery [68,69]. Furthermore, CFGS supports school attendance and engagement by creating stable, welcoming environments conducive to learning and social interaction. These spaces also facilitate trauma-informed care approaches in schools, integrating restorative justice and multicultural education to promote resilience and well-being [70].

4. Multidimensional and Interconnected Recovery

The benefits of CFGS are deeply interconnected, with psychological, physical, and educational outcomes reinforcing one another to foster holistic recovery and resilience [40,71]. For example, reduced anxiety enhances physical activity participation and academic engagement, while improved physical health supports cognitive function and emotional regulation [52,72]. The integrated and interconnected nature of these benefits positions CFGS as essential elements in recovery strategies for children in post-disaster settings. Studies show that children with access to CFGS experience lower levels of anxiety and depression, which in turn enhances their engagement in physical and academic activities [52].

This synergy supports multiple facets of development concurrently, fostering long-term resilience and positive developmental outcomes [71]. As shown in Table 2, CFGS plays a significant role in addressing children's vulnerabilities in post-disaster contexts. Figure 4 illustrates the feedback loops, demonstrating how CFGS environments simultaneously nurture emotional well-being, physical fitness, and educational growth. This integrative role positions CFGS as indispensable infrastructure in post-disaster recovery strategies, promoting sustained child development and community resilience between psychological, physical, and educational outcomes, highlighting the interconnectedness of these domains in promoting resilience and well-being among children affected by disasters.

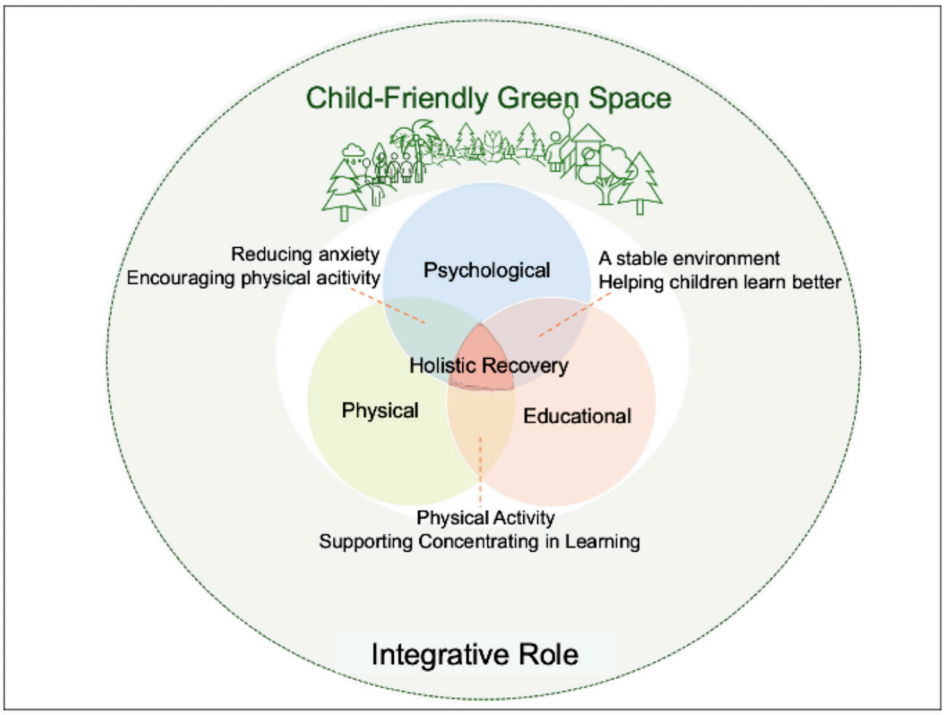

Figure 4. Interconnected benefits of CFGS show feedback loops between psychological, physical, and educational outcomes.

Table 2. Impact of CFGS in addressing Children's vulnerabilities following disasters.

Domain	Key Points	Descriptions	References
1. Psychological	Emotional Stability and mental health symptoms reductions	Support emotional well-being, lower trauma- related mental health, and stress reduction after traumatic events.	[9,10,34,52,57–59]
	Healing Environments	Therapeutic design elements reduce stress, improve recovery, and support cognitive healing.	[28,29,31,35]
	Structured and Unstructured Play	Positive impacts of structured play within CFGS for trauma processing and stress alleviation.	[10,54]
2. Physical	Promotion of Physical Activity	Encourage outdoor play, improving physical strength and facilitating physical activity	[11,60–62]
	Overall, Health Improvements	Improved attention, mood, and physical health observed in children spending time in CFGS.	[52,63,64]
	Development of Healthy Habits	Encouraging outdoor play contributes to the development of healthy cardiovascular and muscle strength.	[12,51]
3. Educational	Cognitive Development	Access to CFGS improves concentration and memory retention.	[13,17,65,66]
	School Attendance and Academic Performance	Correlation between regular access to CFGS and improved attendance/performance.	[14,70]
	Informal Learning Environment	Promotion of creativity and exploration, fostering social skills and emotional intelligence.	[47,68,69]
4.Multidimensional Recovery	Holistic Recovery Tool	CFGS provide overlapping benefits for psychological, physical, and educational recovery.	[40,71]
	Interconnectedness of Benefits	Encourages multifaceted recovery linked to increased participation in physical, social interaction and academic activities.	[52,72]

3.5. Quantitative Assessment of CFGS Impact

Quantitative studies demonstrate significant positive impacts of CFGS on children's mental health, physical activity, and educational outcomes. Overstreet et al. (2011) [10] reported a 30% decrease in these symptoms, measured using the Children's Depression Inventory (CDI), among children participating in structured activities in CFGS located in urban areas. The study utilized pre- and post-intervention assessments to evaluate changes in mental health outcomes. Olteanu et al. (2011) [9] found a 25% reduction in post-traumatic stress symptoms among disaster-affected children engaging with the natural environment. This study employed standardized PTSD scales to measure outcomes, focusing on children in regions affected by natural disasters, thereby highlighting the role of CFGS in fostering emotional stability and resilience. Studies also demonstrate that healing environments designed with therapeutic elements—safe spaces, personal control, and multi-sensory stimuli—significantly reduce stress and improve cognitive healing [27,31,34]. Sensory gardens, especially for children with special needs, provide tactile, auditory, and olfactory stimuli that enhance emotional expression and social interaction, supported by behavioral mapping and interview-based research [12,28,29,35,38,51]. Hirani et al. (2019) [11] observed a 25% increase in outdoor playtime, assessed through activity logs and wearable fitness trackers, among children with access to CFGS in suburban areas, improving cardiovascular health and muscle strength. Longitudinal studies confirm that regular access to CFGS reduces obesity risk and fosters healthy habits [52,53]. Furthermore, the presence of CFGS is linked to enhanced cognitive development and academic performance. Balseviciene et al. (2014) observed a 15% improvement in attention and mood through surveys and observational methods [63]. Dadvand et al. (2015) found a 20% improvement in concentration and memory retention, measured through cognitive tests, among children involved in learning activities in green spaces compared to traditional classroom settings in metropolitan areas [13]. Browning and Rigolon (2019) observed a 10% increase in school attendance, using attendance records, among children with regular access to CFGS, indicating that these environments support educational engagement and recovery [14].

3.6. Synthesis of Findings

This review establishes that CFGS play an integrative and multidimensional role in supporting children's recovery after natural disasters, addressing psychological, physical, and educational vulnerabilities. The evidence demonstrates that CFGS provides environments conducive to emotional stability, stress reduction, and the alleviation of post-traumatic symptoms such as anxiety and depression [9,10]. The opportunity for structured and unstructured play, social interaction, and exposure to nature within CFGS fosters emotional resilience and a sense of normalcy among affected children. Significantly, the work of Hussein (2010, 2012, 2016, 2017) [28,29,35,38] highlights the critical role of sensory gardens and multi-sensory play environments within CFGS, especially for children with special needs. Hussein's research emphasizes the therapeutic and educational potential of CFGS in a recovery context [28,29,35,38]. In addition, CFGS are instrumental in promoting physical health by encouraging outdoor activities, which are associated with improved attention, mood, cardiovascular fitness, and the development of healthy habits [11,12,63]. Educational outcomes are enhanced by improved concentration, increased school attendance, and informal learning opportunities fostered in these spaces, which also support creativity and social skills [13,14,47]. These benefits are interconnected, with improvements in one domain reinforcing others, resulting in holistic recovery and resilience [40,71]. Consequently, CFGS should be considered vital infrastructure in disaster recovery and community resilience strategies.

4. Discussion

4.1. Implications

Green Spaces designed for children are integral to holistic post-disaster recovery, addressing their psychological, physical, and educational needs simultaneously. This multidimensional role positions CFGS as essential infrastructure for sustainable recovery, moving beyond immediate survival to long-term well-being and resilience [40,71]. This approach aligns with the Sendai Framework's "Build Back Better" principle, emphasizing equity, inclusion, and resilience beyond physical reconstruction [73,74].

These spaces foster emotional resilience and social cohesion by providing spaces for structured and unstructured play, quiet reflection, and social interaction, which are vital for children's trauma recovery and ongoing development [10,28,29,31,35,38]. They also support physical health through active play, enhancing cardiovascular fitness and healthy habits [12,51], while also improving educational outcomes such as concentration, attendance, and informal learning [13,14]

Although the benefits of CFGS are well-documented, their effective integration into disaster recovery strategies requires a nuanced understanding of the complex interplay between community needs, cultural contexts, and recovery priorities. Immediate relief efforts often overshadow investments in green space initiatives, and funding for CFGS creation and maintenance is frequently limited [15,27]. Socio-cultural factors further complicate implementation: cultural perceptions of nature, play, and community involvement vary widely, necessitating sensitivity to local norms, gender-specific needs, and community ownership models, as exemplified by post-Katrina New Orleans parks [30,54].

Coordination among multiple stakeholders—including government agencies, NGOs, urban planners, educators, and communities—remains challenging but is essential to secure funding, governance, and coherent implementation [15,27,75,76]. Urban and rural contexts present distinct challenges: urban areas may lack available land, while rural areas may have natural landscapes but insufficient infrastructure for maintenance [77]. Effective recovery frameworks must therefore prioritize participatory planning that actively involves children and local communities to ensure cultural relevance, ownership, and sustainability. Continuous monitoring, evaluation, and community stewardship are also vital to maintain the safety, usability, and therapeutic effectiveness of CFGS over time.

Figure 5 presents a comprehensive framework for implementing CFGS within post-disaster recovery. It delineates sequential stages beginning with the assessment of children's vulnerabilities across psychological, physical, and educational domains; followed by participatory and inclusive design processes involving children and community stakeholders; translation of these plans into functional, safe, and therapeutic green spaces; integration with broader recovery infrastructure and policy systems to ensure sustainability; and continuous monitoring, evaluation, and community stewardship to adapt and maintain CFGS over time. This cyclical and inclusive framework ensures CFGS remain responsive to evolving community needs and maximize their therapeutic, physical, and educational benefits [16,28,40].

Table 3 complements this framework by detailing key action components, objectives, activities, and expected outcomes. For instance, the needs assessment phase involves surveys, focus groups, and observational studies to tailor CFGS to children's specific vulnerabilities [1,72,78]. Participatory design employs workshops and community meetings to foster ownership and cultural relevance (Hussein et al., 2016; Ataol et al., 2019) [16,28]. The design and implementation phases focus on creating multifunctional green spaces that support psychological, physical, and educational recovery [33,34,37]. Integration with recovery infrastructure requires collaboration among landscape architects, planners, and policymakers to embed CFGS within recovery policies and secure sustainable funding [27,32].

Finally, monitoring and evaluation activities, including follow-up studies and community stewardship, ensure sustained safety, usability, and therapeutic effectiveness [5,16,28]. This detailed framework and action plan provide practical guidance for operationalizing CFGS as critical post-disaster recovery infrastructure.

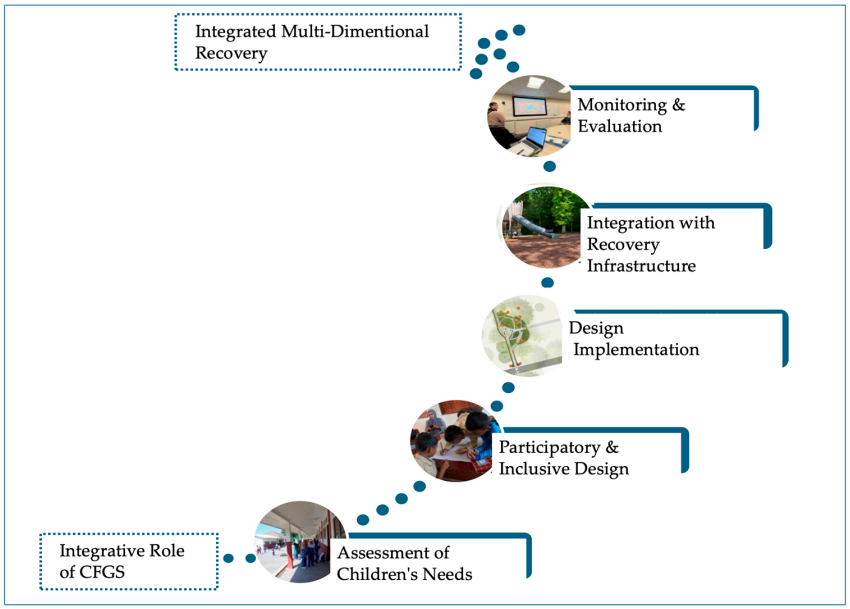

Figure 5. Framework for CFGS implementation.

Table 3. Framework for CFGS implementation.

Action Component	Objective	Key Activity	Outcome and Benefit
Assessment of Children's Needs	Identify children's needs based on children's vulnerability (psychological, physical, and educational).	Conduct surveys, focus groups, and observational studies.	Understand specific needs to tailor CFGS, ensuring effective recovery [1,72,78].
Participatory and Inclusive Design	Co-create solutions involving children, community, and stakeholders.	Workshops, participatory activities, meetings, and discussions.	Foster community involvement and ownership, ensuring relevance, effectiveness, and sustainability [16,28].
Design Implementation	Translate participatory plans into functional, safe, and therapeutic green spaces.	Build multifunctional green spaces, structures/unstructured, and learning environments based on identified needs.	Realize design plans into physical spaces, supporting psychological, physical, and educational recovery [5,28,33,34,37,79].
Integration with Recovery Infrastructure	Align CFGS with broader recovery and policy systems to ensure sustainability.	Collaboration between landscape architects, planners, and stakeholders to embed CFGS into the recovery policies and funding mechanism.	Ensure CFGS are part of a comprehensive recovery strategy, enhancing impact, policy support and sustainability [27,32].
Monitoring and Evaluation	Measure safety, usability, effectiveness, and long-term impact of CFGS.	Conduct follow-up studies, collect feedback, engage the community in stewardship and maintenance, and adjust designs as necessary to improve outcomes.	Refine CFGS through continuous evaluation, increased community ownership, ensuring they meet evolving needs, and maximize long-term benefits [5,16,28,40].

4.2. Barriers to CFGS Integration

Despite the demonstrated benefits, CFGS integration into post-disaster recovery faces persistent systemic, institutional, and site-level barriers. A systemic barrier is the absence of explicit, evidence-based policies and implementation guidelines prioritizing CFGS within disaster recovery and urban planning frameworks. While the therapeutic and developmental benefits of CFGS are increasingly recognized [5,27], many recovery plans lack concrete mandates for their inclusion [15,36]. This policy gap hinders institutional commitment and the allocation of sustainable funding essential for long-term success. Recovery priorities tend to focus on immediate survival needs such as housing and healthcare, often relegating green space development and maintenance to lower priority [15]. This short-term focus limits the resources available for CFGS, despite their critical role in long-term psychosocial

and physical recovery [23]. This underfunding reflects a broader undervaluation of green spaces as critical public health infrastructure [16].

Institutional barriers arise from fragmented governance, unclear stakeholder responsibilities, and limited technical expertise in designing and maintaining sensory-rich, accessible green spaces [27,28,80]. Coordination among government agencies, NGOs, urban planners, educators, and communities remains challenging, impeding cohesive implementation.

Site-level barriers include accessibility and safety issues, socio-cultural attitudes, site design, and maintenance challenges. Urban areas face land scarcity, competing land uses, safety concerns such as traffic and crime, and restrictions on children's access to green spaces [36,81]. Socio-cultural factors such as varying perceptions of nature, play, gender norms, and community engagement influence CFGS relevance and use [30,54]. Without culturally sensitive, participatory design and stewardship, CFGS risk underutilization and deterioration, diminishing their therapeutic and educational impact [16,28]. This comprehensive overview of barriers is summarized in Table 4, which details the categories, describing their nature and proposing strategic recommendations to overcome them and illustrated in Figure 6.

Table 4. Barriers to CFGS integration and recommendations.

Barrier Level	Barrier Category	Description	Recommendation
Systemic	Policy and Guidelines	Lack of clear policies and mandates for CFGS integration	Develop evidence-based policies; embed CFGS in recovery plans
	Recovery Priorities	Immediate relief focus overshadows green space funding	Advocate for long-term recovery funding and strategic inclusion
	Finance and Resources	Insufficient dedicated funding for development and maintenance	Secure sustainable funding streams for CFGS
Institutional	Fragmented Governance	Lack of coordinated governance and unclear stakeholder roles	Establish clear roles and cross-sector collaboration
	Stakeholder Responsibilities	Ambiguity in mandates and accountability	Define responsibilities and improve coordination
	Limited Technical Expertise	Insufficient expertise in sensory and inclusive design	Build capacity and provide specialized training
Site	Accessibility and Safety	Land scarcity, safety risks limit access	Improve safe, inclusive access and infrastructure
	Socio-Cultural Attitudes	Cultural mismatch and low community engagement	Employ culturally sensitive participatory design
	Site Design and Maintenance	Poor maintenance and lack of community stewardship	Promote community involvement and sustainable maintenance

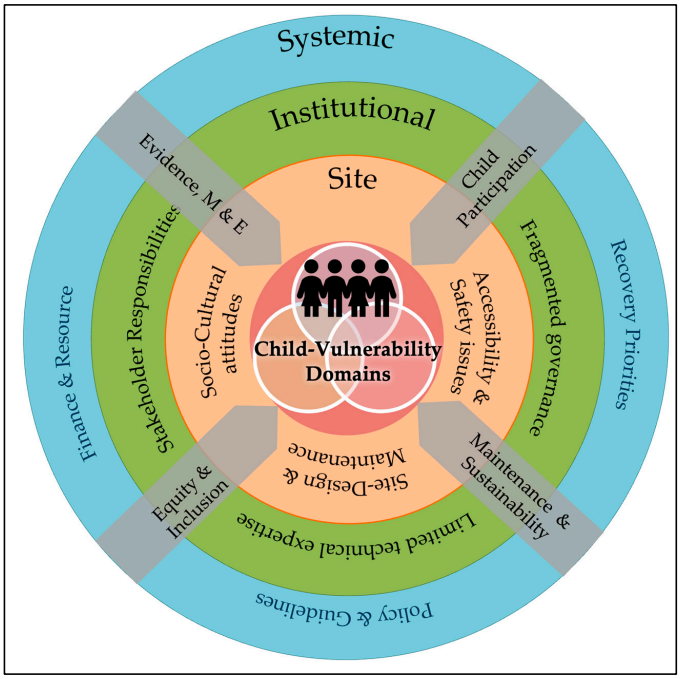

Figure 6. Barriers to CFGS integration.

4.3. Gaps and Future Directions

While CFGS are increasingly recognized as vital for children in recovery post-disaster, significant gaps remain in research, policy, and practice. Recovery efforts often prioritize immediate survival and physical reconstruction, neglecting long-term psychosocial and developmental needs that CFGS address [73,82]. Policy gaps and lack of dedicated funding hinder widespread CFGS adoption [15]. Intervention often lacks cultural sensitivity and participatory approaches, which are essential for ensuring relevance, sustainability, and community ownership [30,54].

Research gaps include a lack of longitudinal, cross-cultural studies assessing sustained impacts of CFGS on children's recovery, especially in rural and low-resource contexts [27,77]. Inclusive design for children with special needs remains underutilized in mainstream recovery planning [27,38,83]. More empirical research and policy innovation are needed to develop standardized, evidence-based design guidelines and participatory models that ensure relevance, sustainability, and ownership [16,54].

Case studies illustrate the critical consequences of neglecting CFGS, such as inadequate psychosocial support following the Tajogaite volcano eruption in La Palma [8], contrasted with successful community healing through CFGS in New Orleans post-Hurricane Katrina [9,30] and post-Tohoku earthquake in Japan [76]. These examples highlight CFGS's transformative potential for equitable and sustainable recovery. These examples underscore the transformative potential of CFGS in promoting equity and sustainability in disaster recovery. Additionally, examples from the Global South highlight CFGS adaptability in resource-limited contexts. Urban initiatives in South Africa and Southeast Asia demonstrate that participatory and culturally sensitive design approaches enable effective implementation of CFGS despite technical and financial constraints [72,77]. These cases expand the understanding of CFGS applicability and inform the development of inclusive frameworks tailored to diverse socio-economic and cultural contexts. Furthermore, attention must be given to urban-rural disparities, as urban areas often confront land scarcity and competition for space, whereas rural regions may lack the necessary infrastructure to support ongoing maintenance and accessibility of CFGS [77].

Addressing these gaps requires a paradigm shift toward holistic, long-term recovery strategies that explicitly include CFGS, supported by culturally sensitive, participatory design standards and robust monitoring and evaluation systems. Aligning CFGS initiatives with SDGs, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 11 (Sustainable Cities and Communities) will help ensure that child well-being and resilience are prioritized in both disaster recovery and sustainable development agendas. Ongoing interdisciplinary research and policy innovation are needed to deepen understanding, refine participatory models, and maximize the long-term benefits of CFGS for children in disaster-affected areas. The CFGS contributions to SDGs are summarized in Table 5.

Table 5. CFGS contribution to SDGs.

SDG	CFGS Contribution	Key References
SDG 3: Health and Well-being	Reduces trauma, supports mental and physical health, fosters active lifestyles	[9,17,63]
SDG 4: Quality Education	Improves concentration, school attendance, supports informal and experiential learning	[13,14,47]
SDG 11: Sustainable Cities	Promotes inclusive, resilient, and participatory urban development; enhances social cohesion	[16,18,74]

5. Conclusions

This study confirms that Child-Friendly Green Spaces (CFGS) are vital infrastructures supporting the holistic recovery of children affected by natural disasters. CFGS effectively reduces trauma-related psychological symptoms such as anxiety and depression, promotes physical health through active play, and enhances educational outcomes by improving con-

centration and school engagement. These interconnected benefits foster sustained resilience and well-being. The review answers the primary research question by demonstrating that CFGS provide safe, inclusive, and nature-based environments that simultaneously nurture emotional healing, physical activity, and cognitive development. Grounded in the Biophilia Hypothesis and Ecological Systems Theory, CFGS serve as critical microsystems that restore disrupted social ties and normalcy essential for children's recovery. The findings emphasize the urgent need to integrate CFGS into formal disaster recovery and urban planning frameworks. This integration aligns with the Sendai Framework's "Build Back Better" principle, which advocates recovery approaches that extend beyond physical reconstruction to include equity, inclusion, and resilience. This requires participatory, culturally sensitive planning that actively involves children, families, and communities to ensure relevance, ownership, and sustainability.

Overcoming barriers such as policy gaps, limited funding, fragmented governance, and socio-cultural challenges demands coordinated multi-sector collaboration and clear policy mandates. Embedding CFGS within recovery policies supports Sustainable Development Goals, particularly SDG 3, 4, and 11, promoting child-centered, resilient, and inclusive recovery. Future research should prioritize longitudinal, interdisciplinary studies and develop inclusive design guidelines to maximize CFGS effectiveness. Recognizing CFGS as integral components of disaster recovery will promote children's well-being and foster resilient and sustainable communities.

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