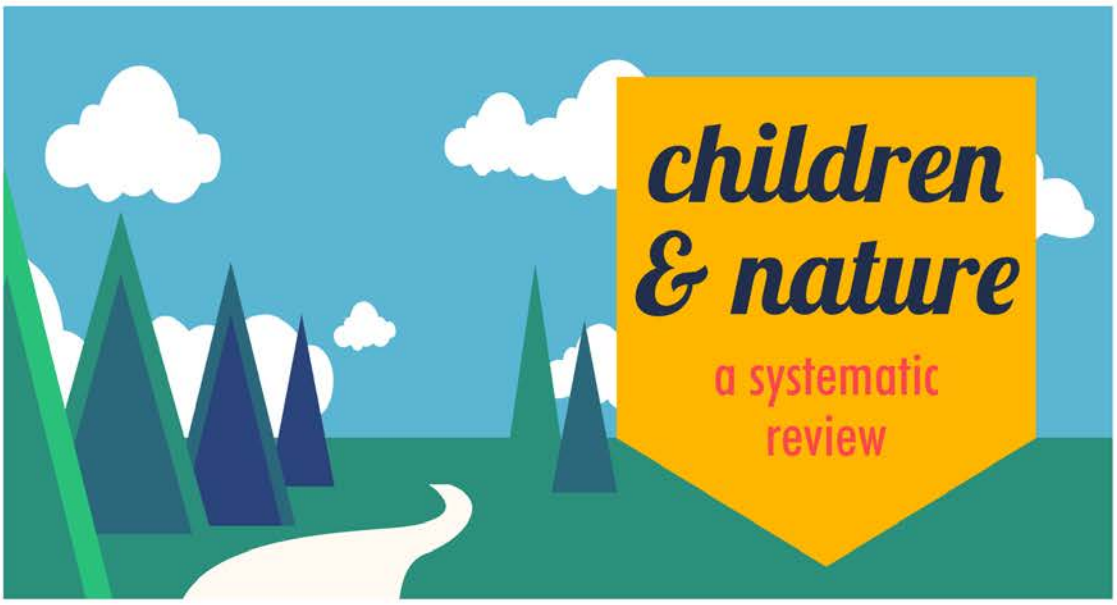

Prepared by: The Human Environments Analysis Laboratory

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HEAL
HUMAN ENVIRONMENTS ANALYSIS LABORATORY

LAWSON
FOUNDATION

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Executive Summary

It is widely believed that connecting children with nature can, to some degree, improve aspects of their physical health, mental well-being, and cognitive and social development. However, evidence to support this contention is extremely diverse, dispersed, and difficult to interpret. The **primary purpose** of this report was to systematically identify, evaluate, and summarize existing empirical evidence from peer-reviewed studies on the impact of exposure to nature on the health and development of children (aged 0-18 years) and, based on the evidence, highlight potential gaps and opportunities for action.

The evidence included in this report was generated from a systematic search of ten bibliographic databases. From these searches, a total of 564,289 titles of articles were identified and screened for relevancy. Abstracts from 5,362 articles were screened further, and 997 full-text articles were read and assessed for eligibility, leading to a final set of 218 articles that were included in the review. Due to vast disparities in the research foci, designs, and methodologies used in the published studies to date, it is difficult to make strong overall conclusions about the benefits of nature for children and youth. Nevertheless, given the rising rates of various physical and mental health issues among Canadian children, and the recognition that children and youth are spending less time outdoors than ever before, the timing is critical for a rigorous systematic review of the empirical evidence on the benefits of nature exposure. This systematic review of peer-reviewed studies published between 1990 and 2016 aimed to answer three key research questions:

*1) How does children's connection with nature benefit their **physical health and development**?*

Findings: The most common benefit/health outcome identified covered among the 154 studies reviewed under this theme was physical activity. More specifically, the research suggests that access to nature can positively influence children's physical activity levels. Various measures/features of nature influence children's physical health, such as living near parks and green space, specific park amenities that are appealing to children. These and features of neighbourhood environments, such as the density of street trees, can push children to be more physically active. It was also identified that nature can play a role in increasing children's fruit and vegetable consumption, when children have direct contact with gardens. A less frequently examined aspect of physical health identified in the review was nature's impact on children's body mass index (BMI) or obesity. Generally, studies demonstrated nature's positive impact in helping children lower their BMI and risk of obesity.

Recommendations: Based on the research evidence, several recommendations can be made to increase knowledge and understanding, which can lead to increased access

to nature. Living in neighbourhoods with greenery and near parks and other public green space increases children's physical activity levels. City planners should (re)design public parks with consideration of those features which either promote or hinder physical activity.

*2) How does children's connection with nature benefit their **mental health and emotional well-being**?*

Findings: The majority of the 31 studies reviewed under this theme focused on the influences of nature for children with ADD/ADHD. A substantial amount of research has been published in this area which collectively indicates that exposure to green settings, open grass, and proximity to green space are all factors that effectively result in milder ADD/ADHD symptoms. Mental health, emotional well-being, resilience, self-esteem, stress, behavioural disorders, and health related quality of life are additional outcomes that were assessed within the peer-reviewed papers included in this review. In general, proximity to green space or parks was positively associated with better mental health and well-being among children and youth, however there is controversy surrounding the effects that green residential surroundings have on mental health and well-being.

Recommendations: Despite the fact that 31 articles were deemed eligible for the review, there is a general lack of research on children's depression and anxiety in relation to nature. These two disorders, especially in adolescent populations, are key outcomes that have the potential to be mitigated by nature exposure. Future research should seek to assess more objective measures of mental health and emotional wellbeing. Furthermore, more research attention needs to be directed toward understanding how nature impacts the mental health and emotional wellbeing of vulnerable or marginalized populations of children and youth.

*3) How does children's connection with nature benefit their **social and cognitive development**?*

Findings: Among the 33 papers reviewed in relation to the third theme, the two most common outcomes were behaviour and academic achievement/performance. The evidence indicates that the natural environment surrounding schools can play a pivotal role in helping children succeed in academics, either through direct (i.e., being outside in nature) or indirect (i.e., views of nature from their classrooms) contact. In terms of behaviour, proximity and access to nature (specifically gardens, parks, and green space) were found to result in adolescents having fewer behavioural and conduct problems. Other studies in this theme examined how children's contact with nature and exposure impacted memory, self-discipline, relationships, focus, and attention.

Recommendations: Outdoor education can provide various benefits to children's social and cognitive development. Integrating outdoor classrooms or outdoor lessons into the

curriculum can be a positive complement to traditional classroom learning. Future research should include more in depth examinations of the influence of nature in the home environment, which has not been as thoroughly researched as the school environment.

Overarching themes and recommendations can be made for all three areas of interest in this review. More research incorporating experimental and longitudinal study designs is critical in order to establish findings that can see substantial change over time and are generalizable. Standardized measures of nature are needed, as questions still remain around what types of nature (e.g., street trees, vegetable gardens, or forest schools) and types of exposure are most beneficial (e.g., direct or indirect); how much nature is needed to have an impact (i.e., 'dose'); and who benefits the most from nature exposure (i.e., subgroups)? The questions of where and when nature exposure has the most beneficial impact on children are also important to pursue further; such questions may best be answered using a mixed-methods approach combining direct observations of children's environmental behaviours with outcomes.

The results of this review will help the Lawson Foundation and other key knowledge users to develop more effective programs, policies, practices, and other interventions connecting children with nature to improve their overall health and well-being. From an intervention standpoint, there is a substantial opportunity to incorporate nature exposure into children's everyday learning and play time through school curricula. Urban planners, landscape architects, and land developers play a key role in developing opportunities for nature engagement in neighbourhoods. These stakeholders can facilitate positive development in children, and therefore should be integrated in the research process to ensure practical translation of findings. Finally, policy makers have the potential to influence how parents and children understand the impact nature has on their development. Emphasizing this impact through programs and education may be the most efficient way to demonstrate to the public the importance of being outdoors.

Introduction

There is a growing body of literature which suggests that direct and indirect contact with nature can create many benefits for health and well-being. However, most of the research to date has focussed on adults, rather than children (Maller, 2009). It is commonly believed that connecting children with nature can, to some degree, bring benefits for their physical health, mental well-being, and cognitive and social development; yet the evidence to support this contention is extremely diverse, dispersed, and difficult to interpret. Studies have shown that exposure to nature has the potential to improve psychological and physiological aspects of health and well-being for children, including increased physical activity levels, better cognitive and emotional functioning, and enhanced creativity and intellectual development (Kellert, 2002; Maller, 2009; Maller & Townsend, 2006; Wells, 2000). Given the increasing rates of obesity and mental health issues among children in recent decades (Tremblay and Willms, 2000), there is an urgent need to more critically examine the potential benefits of nature engagement as an approach for combatting these aforementioned challenges to children's well-being. It has been argued that the relationship that children develop with nature begins at an early age through physical exposure, is long-lasting throughout adulthood, and is important to continuous healthy emotional, cognitive, and intellectual development (Kellert, 2002; Müderrisoglu & Gultekin, 2015). Despite the potential cognitive, social, and health benefits, there has been a marked decline in children's overall exposure to nature over the last 20 years (Burdette & Whitaker, 2005; Kellert, 2005; Faber-Taylor & Kuo, 2006).

Given the benefits that nature contact and exposure can have on children, it is important to further explore the research findings on this association, in order to guide evidence-informed decision-making. The present report aimed to address the overarching question: ***What are the benefits of children's engagement with nature?*** To address this overarching question, we were guided by three specific research questions, as follows:

1. How does children's connection with nature benefit their **physical health and development**?

2. How does children's connection with nature benefit their **mental health and emotional well-being**?

3. How does children's connection with nature benefit their **social and cognitive development**?

In relation to Question #1, numerous claims have been made about the impact of nature on ***physical health and development***. For example, several studies have found higher physical activity levels and lower Body Mass Index (BMI) among children living in areas

with more parks (Gilliland et al, 2012; Tucker et al., 2009). Furthermore, more street trees along the route significantly increases the likelihood a child will walk to school (Larsen et al., 2012).

In relation to Question #2, it has been suggested that spending time in nature provides improvements in children's ***mental health and emotional well-being***. For example, one influential study showed how children who are highly stressed found comfort and decreased stress levels when they were exposed to more green spaces (Wells & Evans, 2003). Emotional and behavioural benefits, such as self-confidence, self-esteem, self-awareness, autonomy, and initiative, are all found to increase with frequent exposure to natural environments (Kochanowski & Carr, 2014; Gill, 2011).

In relation to Question #3, research suggests that being exposed to nature may also offer ***social and cognitive development benefits*** for children, such as enhanced scientific learning, communication skills, and development of positive relationships. Wells (2000) discovered that daily exposure to nature can heighten children's cognitive ability by increasing their ability to focus. Nature exposure for children can also provide various learning and educational benefits. For example, Blair (2009) found that school gardening projects had a positive impact on children's achievement and behaviour.

To answer each research question (#1, #2 and #3), three separate systematic reviews were conducted, each with their own search terms specific to the outcomes in question. In this report, each systematic review will have its own section detailing the overall findings from the eligible studies, with the recurring themes found in the literature. Furthermore, each review has a recommendations section targeting researchers, practitioners, policy makers, and planners to provide potential directions to further explore how nature impacts children and what avenues should be pursued to ensure this relationship is strengthened. A detailed description on our search process and our search terms is also provided in the methodology section of this report.

Methodology

Scoping Review

Following the guidelines for systematic reviews outlined in Petticrew and Roberts (2006), the first step in the review process involved conducting a scoping review. A scoping review involves a preliminary search, before a systematic review, to scope existing literature and assess the types of studies that have been conducted on the topic under study (Petticrew & Roberts, 2006). The scoping review, including an examination of previous systematic reviews, provided critical information in assisting with the creation of the search terms that would encompass all of the relevant literature.

Following the scoping review, a set of search terms for the full review was developed by the lead investigator and senior staff. These were reviewed by the expert advisory panel and further supplemented with additional search terms based on panel members' knowledge of the subject areas. The search process was then reviewed by three research and instructional librarians from Western University. The search terms included a common set of nature search terms (e.g., green space, park) and participant search terms (e.g., child, youth) used in each review. Each of the three reviews (i.e., physical health and development; mental health and emotional well-being; and social and cognitive development) included their own separate outcome search terms that were appropriate for reviewing literature on the specific subject area. A diverse and exhaustive list of terms was generated to ensure that the search was comprehensive for the relevant literature. The final list of search terms is included in Appendix A.

To assist with data selection, inclusion and exclusion criteria were established by the expert panel. It was decided that the review should include only peer-reviewed journal articles published between the years 1990 and 2016, as this time frame represents approximately one generation. In addition, articles had to be written in English or French (Canada's two official languages). Study participants had to be children 18 years of age or younger. This is because the Canadian age of majority is 18 years of age in six provinces (Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Prince Edward Island), and 19 years of age in the remaining four provinces and the three territories. Throughout this report, we use the term child to refer to any person 18 years old or younger. Outdoor and indoor environments (e.g., a classroom, home) were included as study settings, as long as there was a direct contact with nature or views from windows. This is because individuals may achieve various benefits via exposure to nature, not simply direct contact with nature. However, studies using only photos, videos, or computer images to represent nature were excluded from the review. Finally, only quantitative studies were included in this review. While qualitative research can provide important information and context, it is more difficult to assess and compare potential outcomes of nature exposure among results of qualitative studies.

Search Strategy

Ten databases were searched: PubMed, Scopus, PsycINFO, Geobase, ProQuest Nursing and Allied Health, SPORTDiscus, Sociological Abstracts, Leisure and Tourism Database, Physical Education Index, and EMBASE. These ten databases were identified as being relevant to the subject matter, and the inclusion of such a large number of databases ensured a comprehensive search strategy which captured as much pertinent literature as possible. Each database was searched separately for the three systematic review topics.

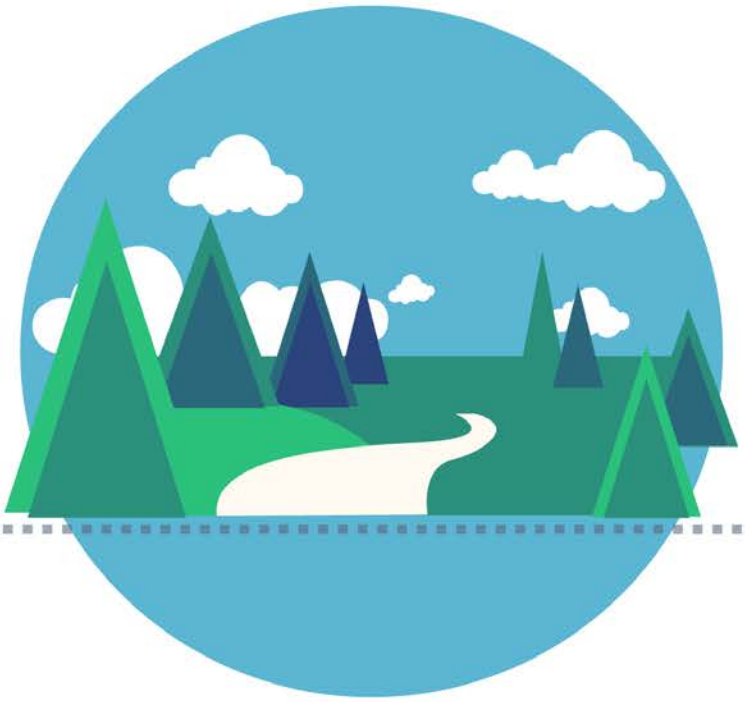
Using the finalized search strings and criteria, relevant articles were identified in the final set of approved electronic databases. Given the large number of articles that each search generated (e.g., sometimes upwards of 20,000), a preliminary scan was conducted based on the article title. If the title was deemed relevant, the article was exported into our respective database set up in Mendeley reference manager software for further analysis. Articles were then reviewed according to title with abstracts to determine relevance to the research questions and inclusion/exclusion criteria. In this step, each article was screened by one graduate student research assistant and one senior staff, with discrepancies settled by another senior staff. All duplicate articles, or those which failed to meet the inclusion criteria were removed from the three databases.

Following abstract screening, the remaining articles were further reviewed for eligibility by senior staff through fill text screens, extracting all relevant information from each article into data extraction tables. Eligibility of each article was reviewed by two reviewers to ensure consistency. Finally, the bibliography/reference lists of the included articles were examined for any additional articles that may have been missed in the original search. If an article was found, it was screened in the eligibility process, to determine appropriateness for inclusion in the final list.

children & nature

a systematic review

Physical Health and Development



1. Physical Health and Development

1.1 Introduction

The first section of this review examines the literature connecting nature and children's physical health and development. Although physical health can encompass numerous different outcomes, food consumption, BMI, obesity, and physical activity were the main dependent variables identified in the literature, meeting eligibility criteria for this review. As demonstrated in the summary table, physical activity represented the most common outcome variable examined in the literature. Within the studies identified, a number of independent variables were identified to represent nature, the most common being: parks, gardens, schoolyards, trees, vegetation, beaches, and home environment.

1.2 Summary by Outcome

Table 1.1: Number of Studies with Physical Health and Development Outcomes

Outcome/Benefit	Number of Studies
Food Consumption	10
BMI and Obesity	28
Motor Development and Skills	1
Health	4
Physical Activity	112

Food Consumption

An important component of children's physical health is their eating habits, particularly food consumption. Poor dietary patterns are sizeable and widespread in children and have been clearly associated with increasing obesity rates. The studies that reported on food consumption examined this outcome through contact with gardens, either school based or community gardens.

The majority of studies found that a school garden positively affected food consumption habits (Hermann et al., 2006). Multiple studies found that gardens in schools increased access to and consumption of fruits and vegetables in children (Hermann et al., 2006; Meinen, Friese, Wright & Carrel, 2012; Parmer, Salisbury-Glennon, Shannon & Struempler, 2009). School gardens can also significantly increase children's willingness to try new fruit, choose fruit or vegetables as a snack over chips or candy, and taste new vegetables that were grown in these gardens (Meinen et al., 2012). This may be because children who take part in the gardening process are more likely to consume more vegetables (Parmer et al., 2009; Morgan et al., 2010), as gardens in a child-care setting offer children hands-on opportunities to taste new fruits and vegetables. However, one study found conflicting results, stating that there was no significant

relationship between school gardens and increased fruit and vegetable intake (Utter, Denny & Dyson, 2015). The conflicting results could be due to age differences of subjects, given that this particular study was with high school aged adolescents, while the other studies examined children 12 years and under.

A community garden can be defined as a “piece of land gardened collectively by a group of people” (Castro, Samuels & Harman, 2013, p. S194). Seven studies examined the influence that community gardens have on children’s fruit and vegetable consumption. The exposure, availability, and accessibility to fruits and vegetables from community gardens were associated with increases in consumption (Spears-Lanoix et al., 2015; Morgan et al., 2010). One particular study found that a garden program positively impacted fruit and vegetable consumption in children, particularly in boys (Lautenschlager & Smith, 2007). Overall, these studies demonstrate the potential impact that school and community gardens can have on increasing children’s fruit and vegetable consumption (Castro et al., 2013).

BMI and Obesity

A second outcome identified in this sub-theme was BMI and/or obesity. Studies demonstrated a variety of variables within nature which had an impact on this outcome for children, such as neighbourhood greenness, vegetation growth, and tree densities. As well, factors such as walkable environments, time spent outdoors, proximity to parks and playgrounds, school environmental programs, and community interventions have also demonstrated an impact on BMI and rates of obesity in children.

Numerous studies identified that children with access to parks and outdoor facilities have a decreased risk of being overweight and obese as measured by BMI (Alexander, Huber, Piper & Tanner, 2012; Fan & Jin, 2014; Wasserman, Suminski, Mayfield, Glaros & Magie, 2014; Wolch et al., 2011). Potwarka, Kaczynski, and Flack (2008), contest this finding and state that while availability of park space does play an important role in children’s weight status, the presence of certain park facilities may play a more crucial role.

In a study by Melius (2013), it was demonstrated that children, on average, are 18% less likely to be overweight or obese when living within walking distance to a park or playground in their neighbourhood. Five additional studies demonstrated that children living near parks, playgrounds, and recreational facilities had lower odds of overweight and obesity, and lower BMI scores (Potestio et al., 2009; Veugelers, Sithole, Zhang & Muhajarine, 2008; Fan & Jin, 2014; Armstrong, Lim & Janicke, 2015). In addition, five studies reviewed showed that residential greenness, residential proximity to forests, tree patches, urban forests, and street tree densities were associated with lower BMI and prevalence of obesity (Lovasi et al., 2013; Dadvand et al., 2014; Kim, Lee, Olvera &

Ellis, 2014; Bell et al., 2008, Sanders et al., 2015). Neighbourhoods with lower availability of these amenities show 20-45% higher odds of obesity rates (Singh, Siahpush, & Kogan, 2010); however, two studies found no direct relationship between nature and rates of obesity and childhood adiposity (Casey et al., 2012; Hrudey, Kunst, Stronks & Vrijkotte, 2015).

School programs, such as nutrition and gardening interventions, showed beneficial results lowering BMI and preventing childhood obesity. Three studies showed the positive impact of school gardens on children's weight and prevalence of obesity (Slaney, Salmon & Weinstein, 2012; Spears-Lanoix et al., 2015; Utter, Denny & Dyson, 2016).

Motor Development and Skills

A study conducted by Fjortoft (2001), determined that children (age 5-7) who used a forest as their playground performed better on motor fitness tests. Their motor skills were improved when compared to children who used a traditional playground (Fjortoft, 2001).

Health

Four studies examined the influence of nature on physical aspects of health including overall general health, asthma, nasal congestion, and sleep. Having larger and more trees in the home neighbourhood was associated with higher health related quality of life (Kim, Lee, & Sohn, 2016) and the probability of being healthy (Kytta et al., 2012). Being outdoors was found to be negatively correlated with health problems such as difficulty sleeping, nasal congestion, and asthma (Hammond, et al., 2011). However, one study found more specifically that street trees were associated with lower prevalence of asthma in children (Lovasi, Quinn, Neckerman, Perzanowki & Rundle, 2008).

Physical Activity

Within the review of physical health and development, the majority of studies identified focused on physical activity as an outcome. Measures and definitions of physical activity were assessed in a variety of ways. Some studies touched upon physical activity intensity (light, moderate, moderate-to-vigorous, or vigorous), while others focused on duration (minutes per day, amount per day or week). Furthermore, physical activity was measured using different means: observation, self-report (either by parents or children), pedometers (step count), and accelerometers. Given the sheer number of studies (N=112) and the level of variability found within the outcome of physical activity, the findings from those studies will be presented differently than other findings. The overall findings will be broken down by the following nature components: parks, proximity to

parks features, schoolyards, school gardens, neighbourhood environment, and tree density. The findings for physical activity are presented below based on their nature variable, to allow for grouping of common findings together (Table 1).

Table 1.2: Number of Studies on Physical Activity by Type of Nature Exposure

Nature Exposure	Number of Studies
Parks	75
Green space	18
Neighbourhood Environment	19
School Environment	19
Gardens	20

Overall Physical Activity

When children participate in physical activity outdoors it is not always in green space. However, a study identified that when boys spend time outdoors their physical activity levels are significantly higher when they are in green space (Wheeler, Cooper, Page, & Jago, 2010). Wheeler et al. (2010) also noted that when children, particularly boys, are physically active outdoors in green space it is at a higher intensity compared to other activities in non-green space.

Parks

A total of 75 included studies discussed the various ways in which parks play an important role in promoting children's physical activity. Generally, studies revealed a positive association between accessibility to parks and increased levels of physical activity in children. Children, particularly teens, were most often observed engaging in vigorous activities in parks, versus walking or sedentary activity (Reed, Price, Grost & Mantinan, 2012). Parks and green spaces provide children with favourable avenues for physical activity (Besenyi, Kaczynski & Stanis, 2013; Cohen et al., 2014; Larson, Whiting, Green & Bowker, 2015). The majority of studies identified that boys were more physically active at parks compared to girls. However, Baek et al., (2015), found that girls were very active in park settings. Within parks, two sub themes emerged: park features and proximity to parks.

Park Features

Certain features, or amenities, commonly found in parks can affect levels of activity in children; therefore, it is important to understand which specific park features do so (Reis, Hino, Florindo, Anez, & Domingues, 2009). One study mentioned that paved

trails led to more intense physical activity, whereas areas covered in dirt, mud, or wood chips resulted in less intense physical activity levels (Baek et al., 2015).

Green areas, as well as parks with a high number of trees, were found to encourage a higher percentage of children engaging in moderate physical activity (Dyment, Bell & Lucas, 2009; Edwards et al., 2015). Those parks which offer lighting around sports courts and equipment were also identified as particularly encouraging of physical activity (Edwards et al., 2015). In addition to the specific features afforded, parks which offered a number of amenities, were associated with more time engaged in physical activity and participation in higher intensity activity (Coughenour, Coker & Bungum, 2014).

One particular study found that the removal of benches within a park was associated with increased activity intensity in children and their parents (Roemmich, Beeler, & Johnson, 2014). This is important because the level of activity observed in parents while in the park positively influences that of the child. Therefore, if parents have less access to benches or seating they tend to be more physically active with their children as parental activity increases when there are fewer places to sit (Roemmich et al., 2014).

Results from these studies highlight not only the type of physical activity children engage in, but also ways to increase their physical activity levels. Within parks, physical activity breeds more physical activity amongst children (Bocarro et al., 2015). Therefore, creating spaces where children can freely engage in physical activity can only positively influence their physical health and development. The development of unused space into a recreational park has shown to significantly increase observed levels of energy expended within the park boundaries in children (King, Litt, Hale, Burniece, & Ross, 2015). This demonstrates that features in a park can influence adolescent's levels of physical activity.

Proximity to Parks

Several studies indicated that living closer to a park was associated with higher levels of physical activity in children and adolescents (Paudel et al., 2014; Epstein et al., 2006; Edwards et al., 2015). Living near parks and beaches increases the opportunities for children and adolescents to engage in physical activity (Grow et al., 2008; Edwards, Giles-Corti, Larson & Beesley, 2014), especially if the park has a high vegetation density (Dunton, Almanza, Jerrett, Wolch & Pentz, 2014). Living near a park also allows children to use active modes of transportation to get to and from parks (Perry, Saelens, & Thompson, 2011), reinforcing physical movement. Being able to walk or bike to the park increases the likelihood of children and adolescents using them, which in turn can also increase physical activity (Grow et al., 2008). These studies demonstrate the positive benefits of having a park near a child's home; however, if the parks are deemed

unsafe, by children or their parents, the likelihood of children using them as a place to be physically active decreases (Echeverria, Luan, Isasi, Johnson-Dias & Pacquiao, 2014; Babey et al., 2008; Babey, Tan, Wolstein & Diamant, 2015).

The information presented in both the features of parks and proximity to park themes, illustrates how influential parks can be in promoting children's physical activity levels. Although some of the findings are contradictory, it is important to note that certain park features play a key role in helping kids be active. In addition, living close to parks provides a great opportunity for children to engage in physical activity.

Neighbourhood

The environment around one's home can provide children with opportunities to engage in unstructured playtime, to be active, and to access to nature. Nineteen studies looked at nature in the neighbourhood analyzing accessibility and diversity of land use mix, street connectivity, walk and cycle infrastructure, neighbourhood aesthetics, public recreation centres, school grounds, parks or playgrounds, trails, beach or lake, vacant lots, family's yards, and friend or relative's house. Studies on neighbourhood and nature have produced mixed results. For example, one study found higher land use mix and gardens were not related to overall moderate-to vigorous physical activity (D'haese, Van Dyck, De Bourdeaudhuij, Deforche & Cardon, 2010), while another found that living in neighbourhoods with green space consisting of meadows, trees, and shrubs was positively associated with the amount of physical activity done during free-time outside of school (Janssen & Rosu, 2015). Neighbourhoods with more sidewalks and parks led to children spending two hours or less in front of screens, being more physically active, and engaging in more active transportation, than children living in neighbourhoods with perceived less sidewalks and parks (Carson, Kuhle, Spence & Veugelers, 2010). The neighbourhood environment can influence children using active transportation as a mode of travel. Street trees can increase children's choice to walk to school (Larsen et al., 2009). These studies all demonstrate how the neighbourhood environment can play a pivotal role in effecting children's physical activity levels.

School

The nineteen studies that discussed green space in schoolyards produced mixed results, as soft surfaces like grass have been found to both increase and decrease physical activity (Cardon, Van Cauwenberghe, Labarque, Haerens & De Bourdeaudhuij, 2008; Barton, Sandercock, Pretty & Wood, 2015; Wood, Gladwell & Barton, 2014). A number of studies suggest green space in schoolyards supports physical activity (Sugiyama, Okely, Masters & Moore, 2010; Dyment & Bell, 2007; Mårtensson et al., 2014); however, others concluded paved sport courts are more conducive to engaging physical activity behaviours (Powell, Woodfield, & Nevill, 2015; Farley, Meriwether,

Baker, Rice & Webber, 2008; Wood et al., 2014). Dyment and Bell (2007) indicated that having diverse landscapes and adequate play space is also important.

In schoolyards, levels of physical activity were influenced by the area or available facilities. Having a large number of facilities in the schoolyards that students can pick from, increases the odds of secondary students being physically active (Haug, Torsheim, Sallis, & Samdal, 2010). For example, school gardens were found to influence physical activity, with participating students showing more moderate physical activity levels than non-participants. However, no significant difference was found for light and vigorous physical activity (Wells, Myers, & Henderson, 2014). Given that the results vary from study to study, this area needs to be further explored.

After-school time as well as summer months, are important unstructured times during which children can be physically active and access nature. One nature-based after school program found that physical movement was increased in summer programs, and that an increase in physical movement was found during the after school program compared to children's time were at home (Kien & Chido, 2003).

1.3 Conclusion

The findings presented above provide us with an overview of research examining how nature can influence children's physical health and development. The vast majority of studies identified nature as having a positive influence on children's physical health. However, additional research is needed to solidify this relationship. Schoolyard designs is an area that still warrants attention. It is necessary to establish what natural environments are best for promoting physical activity, as the current findings are conflicting. Examining outcomes by age and gender can help to create designs that reduce disparities in physical activity.

children & nature

PHYSICAL HEALTH AND DEVELOPMENT

Future Research

- Research is needed to compare nature-based playgrounds versus traditional playgrounds, to see how children with different opportunities engage in physical activity (Barton et al., 2015)
- There is a need for more rigorous evaluations of the promotion and preservation of green space as an approach to address the issue of childhood obesity (Bell et al., 2008)
- Additional research is needed on the effects of 'blue space' (e.g., water) as an element of nature benefits children's health and well being
- More research needed on seasonality and its impact on nature's influence on children; there is a noticeable lack of studies that take place in winter
- More research is needed in non-urban settings, including rural and remote areas, as most work is focused in urban settings
- Research is needed on nature exposure impacts on other critical aspects of children's health such as sleep duration and sleep quality
- There is a need to compare how different types of nature interactions (i.e. quality, duration and dose) influence physical health outcomes
- School-based studies should also examine how school gardens can impact other health benefits beyond physical activity
- Further research is needed using rigorous study design, including using 'natural experiments' and longitudinal designs to isolate effects of nature interventions
- Research should use mixed-methods approaches which combine direct observations of children's behaviours in their local environments with data on health behaviours and outcomes
- There is a critical need to use more fine grained measures of location (e.g., using GPS) to assess more precisely children's actual exposure to green space, not just green space available in the neighbourhood

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PHYSICAL HEALTH AND DEVELOPMENT

Policy

- Zoning policies can be reformed to encourage outdoor space design to be more supporting of physical activities (Kurka et al.,2015)
- Encourage school-based policies and approaches to promote physical activity in natural environments (Eyre et al., 2014)
- Develop strategies to improve parent's attitudes towards involving children in outdoor recreation programs allowing for an increase in children's outdoor play (McFarland et al., 2014)
- Municipal policies can be enacted to add more green space to more neighbourhoods (i.e., more street trees, parks, gardens)

Practice

Urban/City Planners

- Park-renewal/ renovations to make existing parks more attractive to users may facilitate increased amounts of physical activity (Veitch et al., 2012; Cohen et al., 2014; Veitch et al., 2014; Mårtensson et al., 2014; Edwards et al., 2015)
- Increase the number of trees and grassy areas in public housing developments (Faber-Taylor et al., 1998)
- Specific allocation of green space in urban environments (Ebisu et al., 2016)
- Inclusion of community garden sites in park and recreation areas (Castro et al., 2013)

Health Practitioners

- Green school ground space and outdoor environments should be regarded as a highly effective intervention for children's health (Dyment et al., 2009; Pagels et al., 2014)

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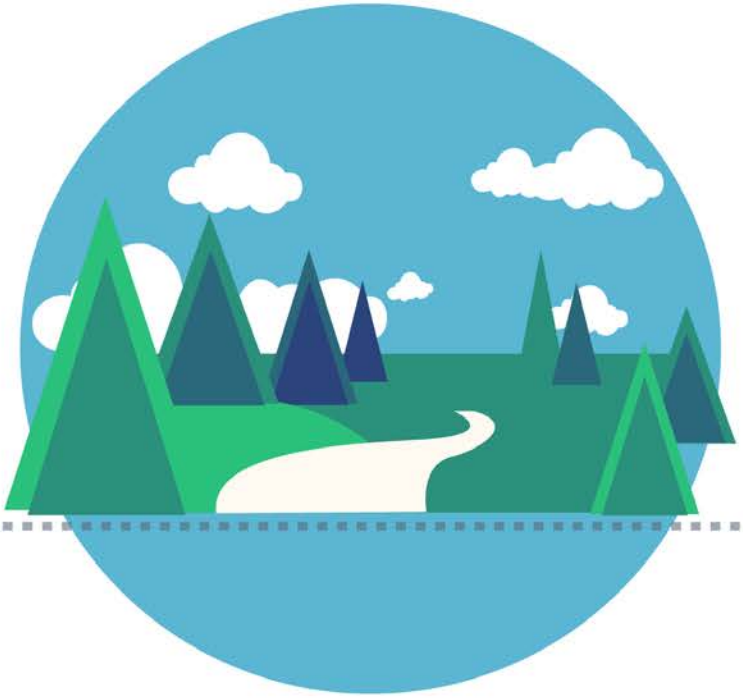
Mental Health and Emotional Well-Being



2. Mental Health and Emotional Well-Being

2.1 Introduction

The World Health Organization (2005) defines child and adolescent mental health as "the capacity to achieve and maintain optimal psychological functioning and well-being". Good mental health during childhood is associated with emotional well-being, reaching developmental milestones, learning healthy social skills, developing sound family and peer relationships, developing a sense of identity and positive self-esteem, and learning resilience and how to cope with stress. Alternatively, the term mental health is also often used when referring to mental disorders associated with impaired brain or emotional functioning (Waddell, McEwan, Peters, Hua, & Garland, 2007). The most common childhood mental disorder examined in the literature reviewed here was attention deficit/hyperactivity disorder (ADD/ADHD).

This summary of findings will highlight specific mental health and emotional well-being outcomes which have been associated with children's engagement with nature. In the studies included in this review, exposure to nature has been measured in a variety of ways, including: time spent in nature, frequency in nature, exposure to green space, proximity to green space, residential/school surrounding greenness, density of vegetation, access to green space (parks), and outdoor adventure camps or wilderness therapy programs. Outdoor adventure camps and wilderness therapy programs are alternative treatment programs where children are exposed to the natural environment as part of their therapy. These programs for the most part focus on vulnerable populations such as juvenile offenders, those suffering from addiction, or children with various mental health disorders.

2.2 Summary of Outcomes

Table 3: Number of Studies with Mental Health & Emotional Well-Being Outcomes

Outcome/Benefit	Number of Studies
Mental Health	4
Emotional Well-Being	10
Resilience	4
Self-Esteem	8
Stress	2
Quality of Life	1
SDQ[a]	1
ADD/ADHD	10
Behavioural Disorders	2

[a] SDQ: Strength and Difficulties Questionnaire

Mental Health

Four studies looked at an overall measure of mental health in children. Most authors agree that nature has a positive impact on children's mental health. Many recent studies have focused on outdoor camps and wilderness therapy programs to assess mental health. Three studies came to similar conclusions about the outcomes associated with camps and wilderness therapy programs: improvements in capacity to self-manage mental illness and disorders (Pryor, Townsend, Maller & Field, 2006); positive significant effects on clinical syndromes, such as anxious feelings, depressive affects, and suicidal tendencies (Clark, Marmol, Cooley, & Gathercoal, 2004), as well as a significant improvement mental health constructs (Harper, Russell, Cooley & Cupples, 2007). These programs generally target more vulnerable or at risk populations, and therefore should not be considered generalizable to the broader population.

Other measures of nature exposure found in the literature include proximity to city parks and residential greenness. In one study, farther distances between the home and city parks were associated with poorer mental health in children whose mothers were classified as the lower maternal education group (Balseviciene et al., 2014). Conversely, in the same study, more residential greenness was associated with worse mental health in children whose mothers were classified as the higher maternal education group (Balseviciene et al., 2014). The contradictory findings in this study alone highlight the need for greater attention on how the effects of nature on children differ for varying populations.

Emotional Well Being

Ten studies highlighted in this review assessed emotional well-being as an all-encompassing term which included variables such as emotional health, emotional intelligence, and emotional problems.

Using the redesign of a schoolyard (experimental versus control), quality of the outdoor play environment, and children attending a forest school (experimental vs control) it has been shown that these "more green" environments improve children's emotional well-being (Kelz, Evans & Röderer, 2015; Roe & Aspinall, 2011; Söderström et al., 2013). In another exposure to nature study, researchers found that children generally reported somewhat more positive feelings in the woods or during a natural exposure. The effect size (0.12) indicates that this may be a significant finding (van den Berg & van den Berg, 2011).

Outdoor camps and wilderness therapy programs are again used in assessing nature exposure in relation to mental health and well-being. Moderate findings suggest that these types of programs show an increase in emotional intelligence and improvement in emotional problems (Harper et al., 2007; Opper, Maree, Fletcher & Sommerville, 2014).

Amoly et al. (2014) reported a statistically significant inverse association between green space playing time and emotional symptoms. Likewise, a study by Flouri, Midouhas, and Joshi (2014), found that neighbourhood green space has the potential to improve emotional health of children in poor families in early life. Unlike these positive associations, two studies found that residential and surrounding school greenness were not significant predictors of children's emotional well-being (Balseviciene et al., 2014; Huynh, Craig, Janssen & Pickett, 2013). Huynh et al. (2013) did, however, find a small relationship between green space and positive emotional well-being in small cities, but this was not a significant trend.

The results for emotional health and proximity to major green spaces or parks were not conclusive in the study done by Amoly et al. (2014), while also not a significant predictor in either group studied by Balseviciene et al. (2014).

Resilience

Resilience is defined as "the ability to effectively cope with challenges, stress, or adversity" (Whittington, Aspelmeier & Budbill, 2016, p. 3). A child who is resilient is "an emotionally healthy individual who is able to successfully confront and negotiate a multitude of challenges, and effectively cope with obstacles, barriers, or setbacks" (Whittington et al., 2016, p. 3). Emotional resilience is an important measure of children's mental health and emotional well-being and is assessed in a variety of child/youth populations. Resilience can be subdivided into measures of sense of mastery, relatedness, and emotional reactivity.

Participation in outdoor programs has been associated with an immediate and maintained increase in overall resilience in certain populations (Ritchie, Wabano, Russell, Enosse, & Young, 2014; Whittington et al., 2016). It was found that outdoor adventure programs and camps resulted in an increase in mastery (improved self-efficacy and coping skills) and relatedness (more comfortable interacting with others), and a decrease in emotional reactivity (ability to manage emotions when upset) (Whittington et al., 2016). Neighbourhood green space also predicted emotional resilience in poor children whose neighbourhoods had a higher density of green space relative to others in less green neighbourhoods (Flouri et al., 2014).

Self-Esteem

Self-esteem is important in addressing mental health as low self-esteem is very common in children suffering from a mental illness (Reed et al., 2013). A variety of nature-based programs have assessed how children's self-esteem is influenced by nature specific therapy or activities. Marginalized youth, juvenile offenders, adolescents ceasing to attend school, healthy school children, and those suffering from mental illness all are populations represented in this area of study (Barton et al., 2015;

Cammack, Waliczek & Zajicek, 2002; Hinds, 2011; Maller & Townsend, 2006; Reed et al., 2013; Romi & Kohan, 2004; Schell, Cotton, & Luxmoore, 2012; Wood et al., 2014). A number of studies have come to different conclusions on the effects outdoor camps or wilderness therapy programs have on self-esteem. For example, Hinds (2011) found that there was no significant effect on self-esteem. However, Romi and Kohan (2004) found that while there was an increase in self-esteem in the wilderness therapy group (experimental), this change was not significant compared to an alternative group in the residential program (control 1). Schell et al. (2012) found that the outdoor camp for those with a mental illness saw a significant improvement in self-esteem in comparison to the control group. Similar to the outdoor camps and wilderness therapy interventions, horticulture programming for juvenile offenders has been linked to an increase from self-esteem pretest scores (Cammack et al., 2002).

Activities in nature have also been used as an exposure to assess self-esteem. Maller and Townsend (2006) found that perceptions of children's self-esteem as recorded by principals and teachers were positively affected by nature based activities in a school setting. However, unlike Maller and Townsend (2006), Barton et al. (2015) found there was no significant change in self-esteem as a result of a nature-based orienteering intervention. Similarly, when assessing school playing environment and green exercise in relation to self-esteem in healthy school children, school playing environment and green exercise did not demonstrate additional improvements in self-esteem (Reed et al., 2013; Wood et al., 2014).

Stress

Feda et al. (2015) reported an inverse association between perceived stress and access to parks in adolescent populations, even after controlling for socio-economic status and physical activity. The total percentage of parks within an 800m radius predicted further reductions in perceived stress. Wells and Evans (2003) found that residential greenness buffers the adverse impacts of stressful life events which supports the connection between nature and children's stress.

Behavioural Disorders

Findings from Russell (2003) indicated that after individuals participated in an Outdoor Behavioural Healthcare Program (similar to wilderness therapy), they saw a reduction on all subscales of the Youth Outcome Questionnaire (repeated measurement of emotional and behavioral symptoms based on parent assessment and adolescent self-reports) of both the self-reported and parent assessment. Behavioural disorders in this study included Oppositional Defiant Disorder, substance disorders, and depression disorders. More difficulties or behaviour problems have been non-significantly associated with further distance to city parks. In contrast to the findings from Russell

(2003) increased residential greenness was associated with more behaviour problems (Balseviciene et al., 2014).

Health Related Quality of Life & Strengths and Difficulties Questionnaires

Faber-Taylor and Kuo (2011) used the Pediatric Quality of Life Inventory (PedsQL) to measure children's health-related quality of life. More open natural spaces (meaning smaller concentrations of trees) have also been shown to have a greater effect on symptoms of children with ADHD relative to children without hyperactivity (Kim et al., 2016; Faber-Taylor & Kuo, 2011).

The strength and difficulties questionnaire (SDQ) is a validated behavioural screening tool for children ages 3 to 16 years. It is divided into 4 difficulties subscales including emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems, as well as a strength subscale for pro-social behaviour. Some papers have presented their results by each subscale, while others use a total SDQ score. Amoly et al. (2014) reported statistically significant inverse associations between green space playing time and SDQ total difficulties, and residential surrounding greenness and SDQ total difficulties. For proximity to major green spaces, the results were not conclusive for total difficulties and each subscale.

Attention Deficit Hyperactivity Disorder (ADHD)

A large portion of the research collected for this review, ten papers, focused on nature's effect on children's ADHD/ADD symptoms. Surrounding greenness, types of green settings, activities in green settings, proximity to green spaces, and time spent in green space are all measures of exposure to nature used when assessing ADHD/ADD.

Surrounding greenness was associated with a reduction in ADHD symptoms overall. Measuring surrounding greenness in a residential capacity resulted in lower ADHD and inattention symptoms (Amoly et al., 2014). A study by Faber-Taylor and Kuo (2011) assessed the impact of green or natural settings on children who had been officially diagnosed with ADHD by a professional. Results were published on children's usual play environments and the after effects of different activities on children's overall ADHD symptoms. One study found that everyday play settings had an effect on overall symptom severity in children with ADHD, green settings having the largest positive impact (Faber-Taylor & Kuo, 2011). Interestingly, children who also identified as being hyperactive saw the benefit of green settings only in open green spaces, not big trees and grass (Faber-Taylor & Kuo, 2011). A second paper reported that green outdoor settings reduced symptoms of ADHD significantly more in comparison to built outdoor/indoor even when the activities were matched across each setting (Kuo & Faber-Taylor, 2004). Finally, a third paper found that children function better after activities in green settings. It was determined that increases in greenery of the setting

contributed to decreases in ADHD symptom severity (Faber-Taylor, Kuo & Sullivan, 2001).

A comparative analysis of a natural and built setting showed that children with ADHD had more difficulty concentrating in the city or town setting. Faber-Taylor and Kuo (2009) measured concentration using a cognitive test called the Digit Span Backwards, and found that concentration after walking in a park was better than after walking through downtown and neighbourhood settings. Similarly, van den Berg and van den Berg (2011) found that participants had more difficulty concentrating in the town setting in comparison to the woods, displaying few concentration problems in the woods.

There is conflicting evidence on the role that proximity to green space plays in relation to ADHD symptoms. Residential proximity to green space was not associated with ADHD indicators in a study done by Amoly et al. (2014). However, it has also been shown that a larger distance to the nearest urban green space was associated with hyperactivity and inattention problems (Markevych et al., 2014). Furthermore, Balseviciene et al. (2014) found hyperactivity in children increased as they became further from city parks in the lower maternal education group. The majority of the research on ADD and ADHD is done with children between the ages of 7-12 years old, therefore further research is needed with children of different age groups, including preschool-aged children, as well as adolescents 13 years and older.

2.3 Conclusion

All of these studies that attempt to establish a link between nature and children's mental health and emotional well-being are, at present, inconsistent in their findings. An exception to this statement is the summary of results on ADHD. There is a consistent benefit of nature exposure for decreasing ADD/ADHD symptoms. Creating a more standardized measure for operationalizing nature is necessary to make these findings generalizable to the population. Understanding why some measures show significant positive changes in various outcomes, while others cause negative effects is another obstacle this research must overcome to generalize the status of children's mental health and emotional well-being.

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MENTAL HEALTH AND EMOTIONAL WELL-BEING

Future Research

- A limited number of existing studies demonstrates the need for replicating findings in similar settings with other populations, and vice versa
- There is a need for additional research focusing on benefits of nature on children's anxiety and depression, especially in adolescent populations
- There is a need to compare how different types of nature interactions (i.e. quality, duration and dose) influence mental health and emotional well-being outcomes
- There is a need for more studies assessing everyday exposure to nature versus specific structured interactions with nature
- There is a need for fine tuning measurement instruments to detect significant differences and changes due to interventions within nature
- Further research is needed using experimental and longitudinal study designs to identify impacts of nature programs and interventions on mental health
- As many studies are based on small sample sizes, further studies are needed with larger sample sizes
- There is a critical need to use more fine grained measures of locality and exposure to greenery (e.g., using GPS) to assess more precisely the proximity of children to green space, not just in children's immediate neighbourhoods (Flouri et al., 2014)

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MENTAL HEALTH AND EMOTIONAL WELL-BEING

Policy

- Development of policies at all levels of government to support greener environments for children facilitating positive changes in mental health and emotional well-being outcomes
- Introduce nature contact into school policies and curriculums as points of intervention to help improve long term mental health and emotional well-being (Dadvand et al., 2015; Flouri et al., 2014; Markevych et al., 2014; van den Berg & van den Berg, 2011)
- The effects of nature on children's health can be more significant in vulnerable/marginalized populations and therefore should be emphasized when creating public policy (Huynh et al., 2013; Wells & Evans, 2003)

Practice

- Continued multi-disciplinary efforts are needed to incorporate urban nature and ecological planning considerations into decision making processes (Kim et al., 2016)

Urban/City Planners

- Green urban planning should be promoted as a tool for supporting children's mental health and emotional well-being (Balseviciene et al., 2014)
- Planners and designers need to build safe, accessible parks within neighbourhoods home to families and children (Feda et al., 2015; Wells, 2000)

Health Practitioners

- Nature based interventions should be implemented alongside playground-based interventions to allow all children equal opportunities as well as facilitate different activities (Barton et al., 2015; van den Berg & van den Berg, 2011)
- Health care practitioners who work with families on a regular basis should emphasize the impact nature has on children's health

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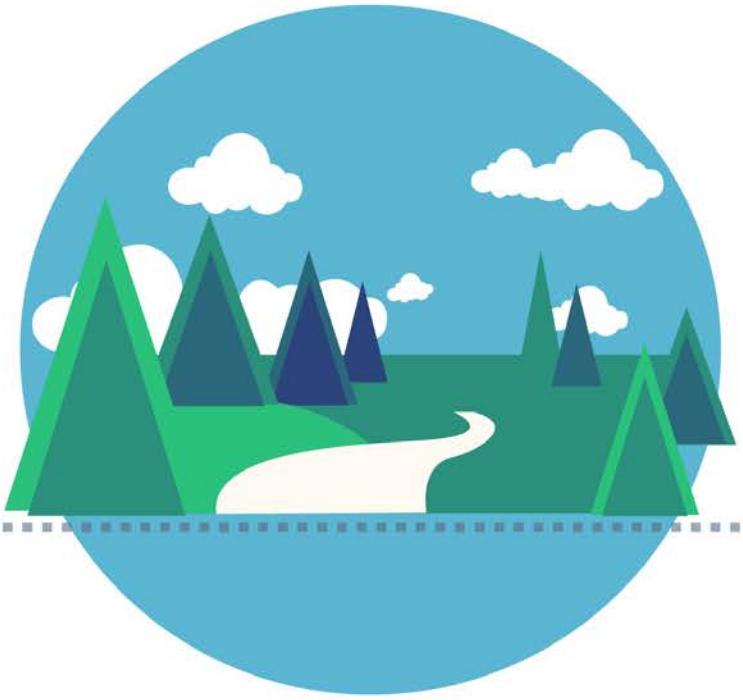
Social and Cognitive Development



3. Social and Cognitive Development

3.1 Introduction

Social and cognitive development can include different indicators including learning, communication skills, and relationship development. The present review identified various outcomes associated with social and cognitive development, such as memory, self-concept, self-worth, behaviour, peer relationships, focus, attention, and self-discipline. One of the most common topics identified was education, which included academic achievement, academic performance, and academic success. Table 1 illustrates the different outcomes/benefits identified and how many studies explored each. The articles included in this review studied these outcomes/benefits in association with various components of nature. The most common settings for exposure to nature included: gardens, parks, greenness, school gardens, forest schools, views of nature, outdoor learning, outdoor camps, wooded areas, trees, and vegetation.

3.2 Summary of Outcomes

Table 4: Number of Studies with Social and Cognitive Development Outcomes

Outcome/Benefit	Number of Studies
Memory	**1**
Academic Achievement, Performance, Success	**8**
Cognitive Function	**3**
Behaviour	**12**
Self-Concept	**1**
Self-Worth	**2**
Relationships	**9**
Focus and Attentional Capacities	**5**
Self-Discipline	**4**

Memory

A study conducted by Dadvand et al. (2015) examined longitudinally how exposure to green space influenced primary schoolchildren's cognitive development, more specifically their memory and inattentiveness. Green space included greenness surrounding both the home and school, commuting route between home and school, and greenness within and around school boundaries. A total surrounding greenness index was applied by averaging all three components of greenness. Greenness within and surrounding school boundaries, commuting greenness, as well as the total surrounding greenness index were associated with an enhancement in memory as well

as a decrease in inattentiveness. No association was recognized between residential greenness memory and inattentiveness.

Academic Achievement/Performance

Outdoor environmental educational programmes, which provide direct contact with nature, help foster children's cognitive achievement (Dieser & Bogner, 2015). Multiple studies looked at the important role nature can play in education, through various avenues. The first was influence of nature on children's academic achievement/performance, and was examined by eight studies. The outdoor lesson often included direct contact with trees, stones, and sticks to enhance learning. When comparing outdoor teaching to traditional classroom instruction, children in the outdoor teaching group improved their performance in mathematical skills more than the traditional classroom group (Fagerstam & Samuelsson, 2014). Furthermore, research with elementary school children showed students who were exposed to more greenness around their school had better academic performance in both Math and English (Wu et al., 2014). Nature's influence also reaches at-risk youth and can impact their educational success (Ruiz-Gallardo, Verde & Valdes, 2013).

An example of outdoor environmental educational programmes is the use of school gardens. School-gardens can be used in academic instruction, and are often used for teaching science, environmental studies, and nutrition (Graham, Beall, Lussier, McLanghlin, & Zidenber-Cherr, 2005). Ruiz-Gallardo et al. (2013) studied the effect of a school-garden learning program on the educational success of disruptive and low-performance secondary school students. The garden-based learning program proved to be successful at increasing the number of school subjects the participants passed in comparison to the previous year. In the previous year, the majority of students failed five or more subjects; however, after the garden-based learning program, nearly all students (93%) failed two or fewer subjects. In addition, dropout rates decreased. Echoing these results, Block et al. (2012) found that a school garden learning program helped children who were deemed as "non-academic" or as having "challenging" behaviour to find success at school. Contrary, Fox and Avramidis (2003) found conflicting results when examining outdoor learning on children with behavioural problems. The conflicting findings demonstrates the need for further research to fully understand the impact that outdoor learning can have on children with behavioural and disruptive problems.

Having a view of natural landscapes from schools can also have an impact on academic performance. Matsuoka (2010) showed the natural environment around a high school campus influenced students' achievement. School grounds composed of mowed grass and parking lots were associated with poorer student performance, compared to school grounds composed primarily of trees and shrubs (Matsuoka, 2010). Research indicated that classrooms and lunch cafeterias with large windows looking out onto nature

positively impacted students' academic success. Nature and green space can play a pivotal role in helping children's academics, through direct contact and by being able to look out into nature.

Cognitive Function

Nature's impact on education is further explored through "forest schools," an approached that has increased in popularity in the United Kingdom. A forest school is defined as "inspirational process that offers children, young people, and adults regular opportunities to achieve and develop confidence and self-esteem through hand on learning experiences in a woodland environment" (Murray & O'Brien, 2005, p.11; Forest Education Initiative, 2006). Forest schools can impact children's development in various ways, such as improving social skills by allowing children to be part of a team and work with others on specific tasks (O'Brien, 2009). Furthermore, forest schools provide an avenue for children to use their imagination more openly, allowing for an improvement in motivation skills and concentration (O'Brien, 2009). Case studies in England and Wales demonstrated that forest schools increased children's self-esteem and confidence, encouraged co-operative work with others, and led to development of language and communication skills (O'Brien & Murray, 2007). They also are shown to positively influence students' cognitive function in terms of energy, hedonic state, stress, and anger (Roe & Aspinall, 2011). This positive influence was greater for students who were deemed to have poor behaviour. Additionally, cognitive dimensions of project planning (efficacy and support) were examined between traditional school settings and forest schools. Although no significant differences were found, it was demonstrated that after a day in the forest school, children had more positive reflection on personal projects (Roe & Aspinall, 2011).

Behaviour

In this review, the term behaviour incorporates both social behaviour (such as social interactions between children) and the impact of nature on children's behavioural problems. Findings for pro-social behaviour or sociability are somewhat conflicting. Annual beach attendance had an inverse association with pro-social behaviour (Amoly et al., 2014). Participation in school gardening programs demonstrated higher sociability in comparison to a control group without the program (Kim, Park, Song, & Son, 2012).While two studies found that there were no significant changes in sociability in children at outdoor camps (Hinds, 2011; Schell et al., 2012), Balseviciene et al. (2014) found differences within two maternal education groups. The lower education group saw pro-social behaviour increase with proximity to parks while the higher maternal education group saw children increase pro-social behaviour with less residential greenness. These conflicting results could be due to the different age range of the participants. The two studies that did not find significant changes involved adolescents

12 years and older, whereas the other studies involved children 7-10 years old. Therefore, it could be that the impact of nature on pro-social behaviour differs according to age. However, it could also be that different types of nature have different impacts on pro-social behaviour among children, even if analyses control for age.

When considering behavioural problems, nature seems to have a positive impact on children. Wilderness therapies have shown preliminary success, demonstrating a significant positive effect on maladaptive behaviour (Harper, et al. 2007; Clark et al., 2004). One study found that children living further away from green space had more overall behavioural problems than those living closer to green space (Markevych, et al., 2014), and that children with access to gardens and parks have fewer conduct problems (Flouri et al., 2014).

Self-concept

Self-concept is the idea one holds about of oneself, constructed by their beliefs and the responses of others in a variety of dimensions (Bracken, 1992). Self-concept was measured globally incorporating the following subscales: social, competence, affect, academic, family, and physical (White, 2012). An outdoor adventure learning camp was found to significantly change adolescents' self-concept (White, 2012).

Self-Worth and Identity Complexity

Self-worth is the personal meaning, purpose, and satisfaction conceptions one holds about oneself (Francis, Gibson & Robbins, 2010). Identity complexity is the capacity to create meaning, being differentiated, articulated, and integrated (Norton, Wisner, Krugh, & Penn, 2014). Self-worth and identity complexity was identified in two studies in the social and cognitive development review. A wilderness program comprised of camping and backpacking through the woods provided positive changes in adolescents' identity complexity and provided them with a greater sense of purpose and self-worth (Norton et al., 2014). Outdoor adventure learning programs led to significant increases in self-efficacy (Ooko, Muthomi, & Odhiambo, 2015). More research is needed to address the complexity of these findings.

Relationships

One component of social development is the construct of 'relationships' with others. This can include either peer, inter-group, or interpersonal relationships. Amoly et al. (2014) reported a statistically significant inverse association between green space playing time and annual beach attendance and peer relationship problems. Other studies found that children living further from parks or urban green spaces experience more peer problems (Balseviciene et al., 2014; Markevych, et al., 2014). The amount and frequency with which parents took their children to neighbourhood green spaces

was related to fewer peer problems (Flouri et al., 2014). School gardens can have positive effects on interpersonal relationships, specifically for 12 to 13 year olds (Waliczek, Bradley, & Zajicek, 2001) while outdoor adventure learning programs increased inter-group relations (Ooko et al., 2015). However, according to Balseviciene et al. (2014), residential greenness did not have a significant impact on peer problems. The inconsistencies found between the studies provide opportunities for future research.

Focus and Attentional Capacities

Five studies examined how nature and greenness can affect children's focus and attention. One study examined whether children who relocated into new housing surrounded by a green natural environment experienced changes in their ability to focus and directed attention capacities (Wells, 2000). The natural environment around a home was found to affect children's cognitive function. Children who were exposed to the least amount of natural environment in the pre-move made the biggest increase in attentional skills post move. Three studies demonstrated children's interaction with nature and the effect on attention. Mårtensson et al. (2009) found that the integration of large areas of trees, shrubbery, and hilly terrains in large green outdoor environments, was correlated with increased attention in preschool children. Maynard, Waters, and Clement (2013) found outdoor classrooms helped children (age 4-7) to remain on task, listen, and focus. Furthermore, a study conducted with 8-12 year olds found that school gardens improved children's attention (Block et al., 2012). An avenue for further exploration would be the influence of nature on attention and focus of teenagers.

Self-Discipline

Self-discipline encompasses impulse, gratification, and concentration. Greener views from the home can have positive associations with children, in regards to self-discipline; however, some differences exist between boys and girls. For girls, having a greener view from their home significantly and positively predicted impulse inhibition (Faber-Taylor, Kuo, & Sullivan, 2002). In regards to boys, there was a slight increase for impulse inhibition associated with views; however, this was not a significant relationship. Girls with greener views from their home were able to delay instant gratification better than girls with less green views. The same was found with concentration, demonstrating that greener views increased girl's concentration levels. For boys, although the links between views of green space and self-discipline were positive, they were not strong. This demonstrates that greener views from the home have a greater impact for girls than boys when it comes to concentration, impulse, and gratification.

3.3 Conclusion

The studies presented in this review indicate how nature can have a positive impact on various components of social and cognitive development. The vast majority of the research is based on how nature can be an asset in children's academic learning and success, as well as its role on children's behaviour. However, future research is still needed to further explore the strength of various relationships in which nature has an influence on children's development.

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SOCIAL AND COGNITIVE DEVELOPMENT

Future Research

- Future research should address how outdoor learning can benefit students with behavioural problems
- More empirical evidence is needed for the benefits of school gardens on children's social, cognitive, and academic development
- Future research should examine the impact of nature in children's home and neighbourhood environments
- There is a need to compare how different types of nature interactions (i.e. quality, duration and dose) social and cognitive development outcomes
- More research using objective measures of nature/green space (i.e., NDVI; GIS) to examine effects on social and cognitive outcomes in children is needed
- Researchers should use longitudinal studies to examine the impact of nature on social and cognitive development throughout childhood

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SOCIAL AND COGNITIVE DEVELOPMENT

Policy

- Introduction of provincial or municipal policies (e.g., through the Planning Act and Official Plans) to ensure that trees and woodlands are planted in all residential environments
- Enact education policies at provincial and/or school board levels to introduce nature teaching into curriculums (Faber-Taylor & Kuo, 2009)
- Having outdoor classrooms integrated into the curriculum as they can be a compliment to traditional classroom learning (O'Brien, 2009)

Practice

Urban/City Planners

- The planning and building of new schools should consider incorporation of nature (e.g., trees) surrounding the school, and have large windows in classrooms and cafeterias looking out into the surrounding green space (Faber-Taylor et al., 2002)
- When new homes and complexes are constructed, plans should attempt to keep old trees, and include grassy areas (Wells, 2000)

Schools

- Focus on enhancing their school grounds to incorporate more greenery such as trees, flowers, and gardens
- Schools should encourage students participate in the upkeep of gardens (e.g., plant the seeds, water the plants, see how things grow) to provide them with a sense of confidence, belonging, control and self-discipline

Conclusion

Over the past decade, the body of literature linking nature exposure and children's health and well-being has continued to grow, with a dramatic spike in the last two years (Appendix F). The present report provides information on the benefits of nature for children's physical health and development, mental health and emotional well-being, and social and cognitive development. The results of this systematic review indicate the numerous ways in which nature can benefit children, and offers avenues to pursue for continuing to exploring this relationship.

In regards to physical health and development, physical activity was the most common outcome measured. The research, for the most part, demonstrates that elements of nature can provide an important pathway for children to be physically active. Given declines in physical activity levels and increases in screen time over the childhood years, this is an important finding. Children who live near parks or green space are more likely to engage in physical activity. Neighbourhoods with more street trees may entice children to use active modes of transportation to get to and from school, which can provide daily physical activity. One area that highlighted conflicting results was schoolyard designs, as some studies showed green space in schoolyards as increasing physical activity while other studies found opposite results. Given the conflicting results, it is an area that needs to be further explored in order to understand how to engage children in schoolyards to partake in physical activity. The review also illustrated the positive benefits of the natural environments on children's obesity rates and BMI levels, and food consumption behaviour.

This review also established the benefits of nature on children's mental health. The vast majority of the studies identified, focused on the impact of nature for minimizing the symptoms of ADD or ADHD in children. Proximity to parks or green space was found mostly to be positively associated with mental health and emotional well-being. However, a variety of studies showed contrasting results with how nature can impact mental health and emotional well-being. A research gap exists in studies examining nature's influence on depression and anxiety in adolescents, which is crucial with an increasing prevalence of these two disorders.

Finally, exposure to nature showed multiple benefits for children's social and cognitive development. The main area of focus seems to be on how nature can benefit children in educational settings. Whether the outcome is increased academic achievement/performance, or enhanced cognitive function to improve focus and attentiveness during lessons, nature exposure seems to play a positive role. The idea of bringing traditional classrooms into the outdoors seems to be a popular trend with demonstrable benefit, and perhaps should be integrated into school curricula. Another main area of focus was the influence that nature exposure can have on children's

behaviour. Research indicates that behavioural problems and conduct problems were diminished when living in proximity to natural environments; however, conflicting results were found between studies, supporting the need for further research in this area.

As highlighted by the recommendation section of each separate review, there are several areas to continue to explore moving forward on the topic of children and nature. There are avenues for researchers to provide us with empirical evidence on the direct benefits of interacting with nature. Professionals/planners can put into practice the recommendations identified through the research. Finally, there are avenues for policy makers at multiple levels to move towards policy that ensures people, specifically children, can benefit from what nature can provide them. It is also important that researchers connect with policy makers and planners, via knowledge translation opportunities, to rigorously evaluate the impact of these natural environment exposures on children's health. Given all of the benefits that nature can have for children, from physical and mental health to social and cognitive development, it is easy to see how important it is to get children outside and into nature.

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