



# Effectiveness of green physical activity for improving health and wellbeing: a narrative review

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**Background and Objective:** There are multiple health and wellbeing benefits associated with both physical activity (PA) and nature exposure. Being physically active in nature provides synergistic effects to enhance healthy active lifestyles by achieving maximum advantages from nature and PA. These benefits play a significant role to address recommended PA levels and the burden of chronic health illnesses among the New Zealand population. The aim of this narrative literature review was to assess the impact and effectiveness of green physical activity (GPA) for improving public health and wellbeing by seeking the evidence-based literature.

**Methods:** This narrative literature review was conducted by utilising the databases like PubMed, Cumulative Index to Nursing and Allied Health Sciences (CINAHL), Scopus, ProQuest, Cochrane, and Science Direct to gather studies published between January 2011 to March 2021. Then final 10 articles were included in this research by using inclusion and exclusion criteria, and by reviewing abstracts. The findings of health and wellbeing outcomes were narratively synthesized and analyzed relating to GPA and association with nature. Also, these health and wellbeing outcomes were assigned into three main categories: mental, physical and physiological, and social and behavioural.

**Key Content and Findings:** The health and wellbeing outcomes were extracted, synthesized and analyzed relating to GPA and association with nature. The findings were assigned into three main categories: mental, physical and physiological, and social and behavioural. The common mental health outcomes as the main health and wellbeing outcome when engaging in GPA and having contact with nature were noted. Additionally, a positive relationship was found between exposure to nature and physical health and social and behavioural outcomes.

**Conclusions:** This review concludes that a number of multidisciplinary approaches were found to be significant in utilising to get the beneficial health and wellbeing outcomes and regarding health promotion and prevention of various chronic and non-communicable diseases, particularly in New Zealand. Further, GPA and nature-based interventions need to be optimized to address the broader range of health and wellbeing issues and to overcome barriers to attending GPA and green exercise (GE).

**Keywords:** Green exercise (GE); green physical activities (GPA); green space; health and wellbeing

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## Introduction

Physical inactivity has detrimental effects and is considered a leading risk factor for global mortality and morbidity rates of non-communicable diseases, negative influences on mental well-being, and poor quality of life (1). Moreover, physical inactivity could be a cause of increased burden of chronic health conditions, which leads to higher annual health care expenditure (2). Adequate physical activities support a healthy lifestyle with significant physical and mental wellbeing and aid in preventing chronic illnesses.

Green physical activities (GPA) or green exercises (GE) are defined as any form of physical activity (PA) or exercise that takes place in urban green spaces like parks and campuses maintained by people with minimal human upkeep (3). The global estimates indicate that one in four adults do not engage in a satisfactory level of exercise and the prevalence of PA has not been raised to the expected levels in the past decade as well (4).

According to the World Health Organization (WHO) the PA requirements are an average of 180 minutes of different types of activities per day for children; approximately 60 minutes of moderate to vigorous activity per day for adolescents; and around 150–300 minutes of moderate or 75–150 minutes of vigorous types of activity per week for adults and older people (1). When considering the New Zealand context, demonstrated New Zealand's prevalence of insufficient physical inactivity in 2016 which was relatively higher than most other developed countries (5).

PA engagement in the natural setting usually provides synergistic health and wellbeing benefits for the population of all age groups in New Zealand. This review aims to assess effectiveness of GPA for improving health and wellbeing and suggest recommendations for the New Zealand population. It provides the stage to analyze the association between the green space and health; assess the possible impact of GPA on health and wellbeing; discuss the effectiveness of nature-based PA practices, knowledge, and awareness among the population.

## Background of green concept and health and wellbeing

The health and wellbeing issues are on rise, in the world, in general, and in particular in New Zealand, as shown by recent studies. Generally, people are trying to engage with nature to improve their health and wellbeing, which is considered as green concept in this regard (6,7).

Residential greeneries, for example, gardens, rooftops, green areas, and urban green spaces such as recreational parks and street trees, provide and promote more attractive and safe environments for outdoor activity engagement (7,8). Additionally, urban green spaces motivate physical activities especially among older women and provide space where people can initiate behavioural change of sedentary lifestyles (9). Also, a significant positive association was observed in reduced unhealthy risk behaviours such as addictive substance use by adolescents with high greenery environments (10).

When considering health and wellbeing, there are positive effects on anxiety and depression, mindfulness, and stress when a person is in contact with nature (11,12). Moreover, green spaces provide and promote positive health behaviours of children and older adults which leads to their improvements in health and wellbeing (13). Additionally, a critically important role between population mental health and the green concept has been identified by two studies (14,15). For example, there is an enhancement of self-rated general health for adults and youth, healthy pregnancies, brain improvement for children, cognitive functions for adults, low risk of developing chronic diseases, and reduction of mortality (16).

## *Effects of GPA on health and wellbeing and interests*

GPA or GE while in direct contact with the actual natural environment, deliver synergetic health benefits for the individuals, and active engagement with nature initiates the stress recovery process. Moreover, GPA can combine with other goals (social contact, entertainment, and leisure) and it promotes both physiological and psychological wellbeing effects (6). Psychological and emotional wellbeing aligns consistently with GPA and it enhances the motivation for future exercise attempts as well (17).

Around 70% of women among ethnic groups in New Zealand take part in walking as PA which fulfils the New Zealand PA guidelines (18). In Norway, researchers concluded that activities such as walking and water sports are the most popular green activities even among adults with lower PA levels (19).

Similar results were found regarding the preferences of outdoor activities among the older population. In that study, gardening is regarded as the second most popular outdoor activity for older adults and the first more common interest is walking (20). Further, outdoor PA (OPA) interests were recorded according to a preferred order among adolescents

as cycling, swimming, and skiing for boys, and swimming, skating and cycling for girls (21).

### *New Zealand GPA practices and recommendations*

Education outside the classroom is a concept introduced by the Ministry of Education in New Zealand for children to spend more time with nature and to attend curriculum-based learning which expands beyond the classroom wall (22). Nature-based education with playing and green physical activities is much more advantageous for children to flourish their future (23). In New Zealand, outdoor walking is highly encouraged by these green prescriptions (24). In addition, GE has been encouraged by the current set of PA guidelines for children, youth, adults, and older people in New Zealand (25).

Also, most research identified that nature-based interventions integrated with green urbanization influences behavioural changes to maximize positive human health status (8,26,27). Hence, potential general health benefits can be obtained by increasing the availability and accessibility of those interventions for the whole population by effectively addressing barriers (28).

### *Justification and potential significance*

Modern lifestyle leads to more negative health consequences such as stressful conditions and distraction from a physically active lifestyle (29). That is one of the reasons why the green outdoor physical activities will enhance both mental and physical health to overcome most negative consequences which are associated with modern lifestyles of individuals.

In New Zealand, mental health conditions such as psychological distress which a person has experienced in the last four weeks, has nearly doubled in 2018/2019 among adults than in 2011/2012 according to the Ministry of Health updates (30). Young adults showed significantly higher rates and moreover Māori and Pacific ethnicities and people living in socio-economically deprived areas indicated relatively increased notifications for these conditions. In addition, obesity, which is a main modifiable risk factor for most non-communicable diseases, was estimated at approximately 30% in adults (one in three adults) and 11% in children (one in nine children) according to the Ministry of Health Annual Key Updates (24).

According to the recent Ministry of Health Annual Key Updates of the PA levels in New Zealand, around half of the adults meet satisfactory levels of physical activities and

one in seven adults engage in PA for less than 30 minutes per week only (25). The above surveys determined that guided criteria of PA levels for New Zealanders were not adequately achieved by the nation.

Therefore, there is a serious need to devise an approachable strategy and framework with specific recommendations for the community particularly in New Zealand context to be introduced for all age groups by eliminating barriers to attending regular physical activities. Similarly, current practices need to be enhanced by age specific recommendations with green outdoor activities, sports, and exercises to maximize effects and outcomes regarding the mental and physical wellbeing of the New Zealand population. We present this article in accordance with the Narrative Review reporting checklist (available at <https://jphe.amegroups.com/article/view/10.21037/jphe-23-26/rc>).

### **Methods**

The aim of this narrative review was to assess the impact and effectiveness of GPA in improving public health and wellbeing by seeking the evidence-based literature. In the health care and public health field, up-to-date data has the most significant value for gaining insight and knowledge about a particular area (31). Also, the combination of the data published in quality articles provides more reliable and accurate information for the narrative summarization, analysis, organization, discussion, and synthesis (32). In this study, a mixed qualitative and quantitative approach was used, which integrates findings from range of qualitative and quantitative approaches to discuss effectiveness of GPA for health and suggests recommendations in the New Zealand context (33,34).

The literature search was performed to achieve significant studies from the well-established electronic databases: PubMed, Cumulative Index to Nursing and Allied Health Sciences (CINAHL), Scopus, ProQuest, Cochrane, and Science Direct. Additionally, other potential studies were identified by searching through the reference list of relevant research. This narrative review addresses the generalization of broad topic of GPA by incorporating the qualitative and quantitative evidence from the available literature. The mixed qualitative and quantitative studies (such as intervention studies, randomized control trials, focus group interview sessions and questionnaire based surveys and assessments) were identified and findings from them were collected to evaluate and synthesize the effects

**Table 1** The summary of search strategy

Items	Specification
Date of search	25 April 2021
Databases used	ProQuest, PubMed, Science Direct, CINAHL, Scopus, Cochrane
Search terms/keywords used	See <i>Table 2</i>
Timeframe	January 2011 to March 2021
Inclusion and exclusion criteria	Inclusion: primary research articles published in English language, between January 2011 and March 2021 with a direct implication of GPA and GE on human populations were included  Exclusion: review articles, publications from non-peer-reviewed journals, publication in any other language than English, published before 2011, not directly impacting human participants or population, or not connected with GPA and/or GE were excluded
Selection process	Authors used PRISMA screening protocol to identify and select research articles and validated by using CASP tool

CINAHL, Cumulative Index to Nursing and Allied Health Sciences; GPA, green physical activity; GE, green exercise; CASP, Critical Appraisal Skills Programme.

**Table 2** Summary of search terms/keywords used in different databases

Name of the database	Search terms/keywords	Number of articles found
ProQuest	("effectiveness" OR "effects" OR "impacts" OR "importance" OR "significance" OR "influences" OR) AND ("green exercise" OR "green physical activities") AND ("associations" OR "relationship" OR "correlations" OR "link") AND ("green space" OR "green exposure" OR "nature" OR "natural environment") AND ("mental health" OR "physical health" OR "mental wellbeing" OR "physical wellbeing" OR "public health") AND ("population" OR "children" OR "adolescence" OR "adults" OR "older people") AND ("recommendations" OR "suggestions") AND ("awareness") AND ("knowledge")	38
PubMed	("effectiveness*" OR "effects*" OR "impacts*" OR "importance*" OR "influences*") AND ("green exercise*" OR "green physical activities*" OR "physical activities*") AND ("associations*" OR "relationship*" OR "link*") AND ("green space*" OR "green exposure*" OR "nature*" OR "natural environment*") AND ("mental health*" OR "physical health*" OR "mental wellbeing*" OR "physical wellbeing*" OR "public health*")	36
Science Direct	("effectiveness" OR "impacts") AND ("green exercise" OR "green physical activities") AND ("associations") AND ("nature" OR "natural environment") AND ("health" OR "wellbeing")	75
CINAHL, Scopus, Cochrane	("effectiveness*" OR "effects*" OR "impacts*" OR "importance*" OR "influences*") AND ("green exercise*" OR "green physical activities*" OR "physical activities*") AND ("associations*" OR "relationship*" OR "link*") AND ("green space*" OR "green exposure*" OR "nature*" OR "natural environment*") AND ("mental health*" OR "physical health*" OR "mental wellbeing*" OR "physical wellbeing*" OR "public health*") AND ("population*" OR "children*" OR "adolescence*" OR "adults*" OR "older people*")	15, 07, 07

CINAHL, Cumulative Index to Nursing and Allied Health Sciences.

and consequences of green concept and GPA on human health and wellbeing. The details of the search strategy are presented in *Table 1*, as well as *Table 2* provides a summary of search terms/keywords and their combinations (Boolean operators) which were used in various databases.

After reviewing the electronic database using inclusion and exclusion criteria, and Critical Appraisal Skills Programme (CASP) appraisal tool also helped to define its critical assessment. According to the given inclusion and exclusion criteria, peer-reviewed and primary research

articles published in English language, during the last 10 years (i.e., between January 2011 and March 2021) with a direct implication of GPA and GE on human populations were included. Similarly, review articles, publications from non-peer-reviewed journals, publication in any other language than English, published before 2011, not directly impacting human participants or population, or not connected with GPA and/or GE were excluded. Analysis of the collected data was done by summarizing and evaluating according to key findings, strengths and weaknesses, limitations, appropriateness of methodology for aims and objectives of study, quality and interpretation of the results, and impacts of conclusion for relevant fields (34-36). Current data were comprehensively structured to identify the key findings towards the successful achievements of the association between health and wellbeing of individuals and GPA, its significant advantages, awareness of GPA practices, and way of improving GPA in New Zealand. Finally, narrative review for this research topic interprets meaningful discussion after the evaluation of credible quality articles for recommendations of GPA in the context of Aotearoa.

### Key findings

The findings and outcomes of the selected articles are presented in this section as per the research questions, aims and objectives of this review. The narrative synthesis and data analysis were done by comparing, contrasting, discussing, and critically evaluating the findings. The following aspects were extracted from the selected literature which help synthesize results through the generation of new concepts and recommendations by exploring and interpreting the contents of final articles. The key findings are summarized in *Table 3* to get a clear synopsis as extracted from the selected articles in this review.

#### *Health benefits from GPA*

The synergistic health benefits are explained and described as a significant factor of the GPA. The major effects of health and wellbeing outcomes of the nature-based activities and contact with nature can be divided into physical and physiological, mental, and social and behavioural. The most important and persistently observable health and wellbeing outcome was the mental health outcomes.

The feeling of anxiety, positive and negative effects, perceived stress, and working memory. In their study,

they measured those parameters by collecting the data by questionnaire in pre- and post-psychological assessments after walking activities. This study reported moderate walking in the forest setting correlated with greater improvements in psychological outcomes compared to roadside walking and daily living activities. When considering the positive effects, walking itself played a role for the improvement of the mental state regardless of location. There was the highest increase of positive effects following the forest walk. In contrast, there was slight decrease of positive effects in roadside walks and much higher decline observed after daily living activities. Altogether following the daily living activities higher perceived stress was observed. There was no correlation between working memory and walking intervention (42).

#### *Vitamin supplementation and GPA*

Another study was conducted in Iran, examined the effect of vitamin D in depression and whether OPA is more beneficial than indoor PA. The results of the study revealed a higher proportion of depression level improvements in the participants who had vitamin D treatment or supplementation and outdoor PA. There was a significant decrease in depression levels from severe to mild in women engaged in outdoor exercise with the treatment of vitamin D. There was a significant increase between the pre- and post-measures of serum vitamin D levels observed in the group of women who exercised outdoors with vitamin D treatment [i.e., OPA with vitamin D treatment (OPA + VD), indoor PA with vitamin D treatment (IPA + VD), and OPA without vitamin D treatment (OPA - VD)]. Outdoor environments provide vitamin D therapy through skin which play a key role in balancing stress hormones to reduce stress by helping the functions of neuroendocrine and the central nervous system (39).

#### *Health benefits from GE*

The study conducted by Glover & Polley [2019] aimed to assess the effectiveness of a 40-day GE intervention regarding physical, physiological, and psychological wellbeing of adults. They discovered that the 40-day GE intervention showed statistically significant positive improvements of psychological parameters including depression, anxiety, stress, and mental health wellbeing. Similarly, self-efficacy also increased but this was not statistically significant (44).

Table 3 Summary of key findings from selected studies

No	Author & year	Country/ region	Title	Aims	Subjects & methods	Main findings	Limitations
1	Rogerson <i>et al.</i> , 2016 (37)	UK	Influences of Green Outdoors versus Indoors Environmental Settings on Psychological and Social Outcomes of Controlled Exercise	To compare psychological and social outcomes of green outdoor exercise and indoor exercise by controlling mode of exercise and intensity  To examine the way of influence for the health outcomes by environment setting	24 participants—12 pairs—from university students and general public  All—completed baseline and experimental conditions  Baseline—documentation, basic health measures, familiarisation of test scales and baseline questionnaire  Experimental—cycle ergometers set up in indoor lab and outdoor grass area  6 pairs—indoor setting  6 pairs—outdoor setting  Experimental—in both conditions, measurements of blood pressure and heart rate, pre- and post-questionnaire and task for the attention measures, social interaction observations and 15 minutes cycling exercise had taken place  Also, mood, attention, enjoyment, perceived exertion, and intention to engage with further exercise were measured	Statistically significant condition (indoor and outdoor) by time (pre-test and post-test) effect corporation  No significant findings for order (outdoor first, indoor first) by condition by time effect  Directed attention indicated improved for conditions in the outdoor environment  Poor results were observed in the indoor exercise conditions (statistically significant attention—condition by time effect)  Social interaction time- for condition effect—positive increase—this has positive influence for further exercise behaviours  No significant findings (time by condition effect)—mood  No significant results for condition effect—enjoyment, intention of further exercise and perceived exertion	Partner selection and background of exercise setting—not controlled  Day of week—conduction of exercise—not controlled  Because of that, changes can happen for influence of exercise effectiveness  Only one environment compared—cannot be generalised for other outdoor settings such as forest, parks, and natural roads
2	Shanahan <i>et al.</i> , 2016 (38)	Australia	Health Benefits from Nature Experiences Depend on Dose	To assess the correlation between frequency, duration and intensity of nature exposure and health in an urban population	1,538 participants—residents in Brisbane city  Aged 18–70 years  Respondents were asked to record and describe any green outdoor space experience in the previous week  3 aspects of nature dose measured by self-report and remote sensing analysis  3 aspects are duration of experience in nature, frequency of experience of nature, nature intensity  Participants provided health outcome information by questionnaires regarding mental health, physical health, social health, health behaviour	People who had long visits to green spaces experienced low proportions of depression and high blood pressure, and higher PA levels  More frequently visited individuals had higher social cohesion  High physical activity levels associate with both frequency and duration of green space visits  Outdoor green visits of 30 minutes or more per week—lower the prevalence of depression and high blood pressure by 7% and 9% respectively	Self-report online survey brought some difficulties which affect their responses including recalling system difficulties and order of questions which may affect participant's responses  Broader socioeconomic background of participant may affect interaction with nature  Participant's attitude and perceptions affect the way of feeling the connection with nature—potentially interact with their health and wellbeing outcomes
3	Irاندoust & Taheri, 2017 (39)	Iran	The Effect of Vitamin D supplement and Indoor Vs Outdoor Physical Activity on Depression of Obese Depressed Women	To examine the impact of Vitamin D in enhancing depression and comparing the benefits of outdoor physical activity with those of indoor physical activity	75 participants with vitamin D deficiency (vitamin D level <20 ng/dL), obesity (BMI: 30–35 and body fat >40%) and depression (score 30 in Beck Depression Test)  4 groups of women—underwent similar intensity of indoor(treadmill) and outdoor (jogging) exercise with vitamin D treatment (IPA + VD, OPA + VD) and without  Exercise—5 minutes warmup and stretching events, 50 minutes main workout, 5 minutes stretching event—4 times a week for 3 months  Vitamin D supplement—2,000 IU per day for 12 weeks  Daily dietary vitamin intake—taken  Vitamin D levels and depression status were assessed before the study and after 4 months	Vitamin D concentration- significantly increased in groups of IPA + VD, OPA + VD, outdoor physical activity without Vitamin D  Depression levels—significantly decreased in IPA + VD, OPA + VD, outdoor physical activity, and indoor physical activity groups	Because of the sun exposure time difference among black and white people to produce same amount of Vitamin D—difficult to generalise for both black and white population  Number of participants were low—generalisation issue

Table 3 (continued)

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No	Author & year	Country/region	Title	Aims	Subjects & methods	Main findings	Limitations
4	Han, 2017 (40)	Taiwan	The effect of nature and physical activity on emotions and attention while engaging in green exercise	<p>To investigate how and whether PA in nature produce synergistic effects on emotions and attention</p> <p>To measure and examine the interactions between effects of amount of green exposure and physical activity</p>	<p>Randomized control trial—5 months</p> <p>116 participants—university students</p> <p>Randomly assigned—walking or jogging in natural (natural road) or low visible greenness environment (built road)</p> <p>Visual greenness—estimated by photo shots and PA levels also recorded</p> <p>Pre- and post-emotions and attention conditions—measured by self-reported questionnaire and standardized tests</p> <p>Four experimental treatments assigned randomly</p>	<p>15 minutes low or moderate PA with at least 40% greenness—58% variance than nature alone—more beneficial for emotions and attention</p> <p>Walking—better than jogging—without increase fatigue</p>	<p>University students attended—cannot generalise for whole population</p> <p>Visible green space measured once at the beginning of the study only—environment can be changed across five-month period</p> <p>Distribution of fence and gardens behind the road can affect participant's response</p> <p>Natural road and busy road—cannot be considered as the best places of nature to measure effects of nature</p>
5	Chiumento <i>et al.</i> , 2018 (41)	England	A haven of green space: learning from a pilot pre-post evaluation of a school-based social and therapeutic horticulture intervention with children	<p>To assess the mental wellbeing of children engaged in “A Social and Therapeutic Horticulture intervention (The Haven of Green Space)”</p> <p>To examine the significance of evaluation methods and “Five Ways to Wellbeing” action framework</p>	<p>36 school children—two primary schools and one secondary school</p> <p>Aged 9–15 years and having behavioural, emotional, and social difficulties</p> <p>Monthly sessions for 6 months—conducted with two horticulturists and a psychotherapist</p> <p>Each session—2 hours long</p> <p>Employed with “Social and Therapeutic Horticulture” and psychotherapeutic techniques in five ways of action</p> <p>To achieve the evaluation—mixed method triangulation evaluation design</p> <p>Primary outcomes of mental wellbeing—measured by Mental Wellbeing Impact Assessment (qualitative) in pre- and post-intervention and Wellbeing Check Cards (quantitative)</p> <p>Teachers were also interviewed to assess mental health status of children</p>	<p>Significance of the intervention is benefit for mental wellbeing of children with behavioural, emotional, and social difficulties in emotional and self-help</p> <p>Acknowledge social interaction and then correlate with positive trends to mental and emotional wellbeing of the children</p> <p>However, Wellbeing Check Cards—negative scores for many factors</p>	<p>Lack of control group</p> <p>Lower number of children participation</p> <p>Challenges of the mental health and wellbeing measurement tools to measure the association between greenspace and mental health</p> <p>Wellbeing Check Cards—not effectively responds by children as it had limitations to measure changes over the period of time</p>
6	Koselka <i>et al.</i> , 2019 (42)	USA	Walking Green: Developing an Evidence Base for Nature Prescriptions	<p>To assist the development of evidence-based suggestions for the nature treatment process</p> <p>To develop the protocol to assess different types of mental and physical wellbeing outcomes</p>	<p>38 participants—undergraduate, graduate and employees from North-western University and residents</p> <p>Equal number of men and women aged 18–35 years</p> <p>Randomized cross over design—conducted in 29 days—2 series</p> <p>1 Series—day 1 to day 15</p> <p>2 Series—day 22 to day 29</p> <p>Beginning—survey to assess their psychological and cognitive condition</p> <p>Then completed psychological assessment—assessment 01</p>	<p>Moderate walking in the forest contributed for the positive impacts for psychological health</p> <p>Forest walk indicates high outcome measures than roadside walk and after daily living activities</p> <p>For positive effects—walking alone provide better mental health outcomes and highest increase following forest walk</p> <p>For negative effects—great improvements after forest walk</p> <p>For anxiety—higher reduction after forest walk</p> <p>For perceived stress—reduction was more following forest walk compared with road walk</p> <p>Working memory showed—no changes</p>	<p>Defect in wording of one response scale used in this study to measure anxiety levels had changed and not discovered until research finished</p>

Table 3 (continued)

Table 3 (continued)

No	Author & year	Country/ region	Title	Aims	Subjects & methods	Main findings	Limitations
7	Aliyas, 2021 (43)	Iran	Physical, mental, and physiological health benefits of green and blue outdoor spaces among elderly people	To evaluate the effects of designed natural outdoor exposure and type of spaces usage on physical, mental, and physiological health in elder people  To assess this relationship can be influenced by the modification of socio-economic status of individuals	Each participant was engaged for two series of 50 min walk Busy road forest preserves After walk—psychological assessment 02  Activities of daily living—non-walking days—include 2 hours daily activities (no vigorous activities)  Psychological assessment includes—positive and negative effects schedule, state, and trait anxiety inventory, Cohen's perceived stress scale, visual backward digital span test  Cross sectional field survey  Population-based randomized sample of elder population aged 65 years or more  Number of elder people—978 attended  Park type, access, visitation, length of stay noted by the participants  Questionnaires were adopted to gather health outcome information—filled at health centres, household, and community spaces	Blue space associated with higher health status  Proportion of green space visits were more than blue space visits  Park access correlate with physical health and not with mental health  Length of the park visit, physical activity levels—positively associate with  Physical and mental health  Most common activity type—sedentary and light aerobics  People with cardiovascular disease—more likely for frequent visit in green space  People with hypertension—less often visit to parks and preferred blue space visits  Duration of park visits, and physical activity levels were no association with cardiovascular and hypertension condition  Had an association of socio—economic variables and all health variables	Cross sectional design  Bias—because of self-report of respondents  The presence of cardiovascular disease—reported by participants—may not be correct  Use of park may be affected by older peoples' physical and psychological health conditions  Focused only on two physiological conditions  Not considered about the factors which affect the use of parks and other build environments
8	Glover & Polley, 2019 (44)	Australia	GOING GREEN: The Effectiveness of a 40-Day Green Exercise Intervention for Insufficiently Active Adults	To estimate the program adherence and compliance of 40-day green exercise and to assess general health variables (physical, physiological, and psychological)	Adults (18–60 years)  23 participants initial  17 fully participated  3 group sessions/week—to increase participants' energy expenditure  On other days/week—30 min/day individual green exercise—walking, rock—climbing, canoeing, team games, activities, yoga, cycling in parks, riversides, beaches	Compliance—high in post intervention  Exercise protocols adherence, compliance, and energy expenditure—higher in group sessions than individual  Blood pressure, weight, hip girth, total cholesterol, aerobic fitness, dynamic stability, and physical activity minutes—positively increased (similar compared to indoor settings)  Wellbeing and self-efficacy—positive changes observed—not statistically significant  Depression, anxiety, stress—decreased significantly	Modest number of sample size—significant changes can be observed and increase the confident of the results by larger number of samples size  Mean age of the participants group is much higher than comparative group—can be affect the influence of participants for effective exercise attendance  Different compliance rate—between group and individual sessions— affect confident conclusions for effectiveness of GE

Table 3 (continued)



Table 3 (continued)

No	Author & year	Country/ region	Title	Aims	Subjects & methods	Main findings	Limitations
					Sessions—intensity of exercise increase gradually Tested pre- and post-(weekly basis) health and wellbeing variables by questionnaires and measurements Exercise attendance records, diaries maintained	Overall mental wellbeing—improved significantly	
9	Müller-Riemenschneider <i>et al.</i> , 2020 (45)	Singapore	Effectiveness of prescribing physical activity in parks to improve health and wellbeing—the park prescription randomized controlled trial	To assess the effectiveness of PPI in improving overall physical activity behaviours, quality of life and health and wellbeing	Randomized control trial  160 participants—middle-aged adults 40–65 years  Nine months intervention period—two groups  Park Prescription Intervention group—face to face communication sessions and weekly exercise  Control group—daily routine  Primarily—time spend for MVPA measured  Secondary—physical activity related behaviours, mental and physical health parameters	Objective measurements—time spent for MVPA and volume of physical activity—higher in Park Prescription Intervention group than control group, but no statistically significant difference  Self-reported—mean time expenditure in parks (minutes/week), physical activity engagement in parks, and recreational activities in parks—statistically significant outcomes  Self-reported time allocation of MVPA—higher in Park Prescription Intervention group—but not significant  Psychological quality of life—significantly increased in Park Prescription intervention group  Finally, Park Prescription Intervention improved—physical activity in parks, usage of parks, recreational physical activity in parks, psychological quality of life	Study population is not representing the general population in the country
10	Park <i>et al.</i> , 2020 (46)	South Korea	Effects of Forest Therapy on Health Promotion among Middle-Aged Women: Focusing on Physiological Indicators	To verify the effects of the Forest Therapy intervention on middle-aged women as health promotion	53 middle-aged women—assessed physiological indicators  Aged 40–64 years  Group one—3 days in forest and 3 days in city  Other groups—3 days in city and 3 days in forest  All participants engage following  Day 1—orientation, questionnaire completion, blood collection for the serotonin and vitamin D level, lying down meditation, Seon Yoga  Day 2—serotonin walking on a forest trail, lying down meditation, healing touch, stress relief meditation  Day 3—natural meditation, questionnaire completion and final blood collection for serotonin and vitamin D level	Meditation and exercise program in forest associated with significant increase of serotonin levels than urban setting  In the same way in forest setting inhibit the decrease of vitamin D level. Vitamin D levels did not show significant increase  Forest therapy—positive improvement of mental health, depression, anxiety  Forest therapy helped to promote health, prevent disease, and improve quality of life in middle-aged women	Slight differences in order of the program content in day two program on control and experiment group—affect the results and cause bias  Only one specific age group was attended for the study—cause difficulties for the generalisation

PA, physical activity; IPA, indoor physical activity; OPA, outdoor physical activity; VD, vitamin D treatment; GE, green exercise; PPI, park prescription intervention; MVPA, moderate-to-vigorous physical activity.

### *Health benefits of PA in nature*

Another study was conducted by Han [2017] as a randomized control trial in Taiwan to investigate how and whether PA in nature produces synergistic effects on emotions and attention. The study objectively measured and examined the interactions between effects of amount of green exposure and PA. A low or moderate level of 15 minutes of PA such as walking in the presence of at least 40% visible greenness was beneficial for emotions and attention. Moreover, the hypothesis of attention restoration theory and stress reduction theory were partially supported by the findings of the study (40).

Another study by Rogerson and co-workers [2016] compared psychological and social outcomes of green outdoor exercise and indoor exercise by controlling the mode of exercise and intensity and the influence on outcomes of the environment setting. The statistical analytical results showed a statistically significant condition (indoor and outdoor) by time (pre-test and post-test) effect and no significant findings were observed for the order (outdoor first, indoor first) by condition by time effect. The directed attention indicated improved conditions in the outdoor environment and poor results were observed in the indoor exercise conditions. Also, for the directed attention, statistically significant results were found in the condition by time interaction. However, according to the results of repeated measurements for mood, a statistically significant relationship for time by condition was not observed. Likewise, non-significant associations were found for the measures of enjoyment and outdoor-indoor setting in condition effect as well (37).

Another researcher studied the correlation between intensity, frequency, and duration of experiences with the natural environment and health and wellbeing measures among urban communities. The results revealed a higher proportion of green exposure associated with more positive health outcome measures. A lower prevalence of depression and high blood pressure was observed among residents who had visited green spaces for a longer duration. In relation to the nature dose-response relationship, health improvement for depression was showed by reduction of prevalence rates by 7% when participants engaged with nature for a duration of at least 30 minutes or more per week (38).

### *Health benefits of nature-based interventions*

Nature-based interventions play a significant role in

influencing and shaping health by maximizing synergistic effects of GPA. This is because of the increased level of urbanization, lack of physical activities and connectedness with nature, and high prevalence of non-communicable diseases nowadays (36).

To determine the effects of Forest Therapy in relation to the physiological wellbeing of middle-aged women (40–60 years old), this study organized three-day programs and events in the forest and the city to help promote the concept of health. Evaluation of the physiological effects was done by investigating serotonin and vitamin D levels (46).

Out of the 10 selected articles, mental health and wellbeing outcomes can be regarded as the most common health and wellbeing outcome of participants who engaged in GPA or were in contact with nature. These psychological health and wellbeing outcomes include positive improvement of depression (38,39,44,46), reduction of anxiety (42,44,46), decrease of stress (42,44), positive changes of overall psychological health and wellbeing (41-46), improvements in attention (37,40) and positive changes for emotional wellbeing (40,41). There were no changes to mood and enjoyment (37) and no changes to working memory (42).

When considering physical health outcomes associated with nature, there was a strong positive correlation of physical health outcomes with length of park stay and level of PA. Additionally, there was a positive relationship of physical health outcomes when participants had access to a park. Also, no association was observed between physical health outcomes and the frequency of park visitation (43). Another study conducted by Müller-Riemenschneider *et al.* [2020] to investigate the effectiveness of a Park Prescription Intervention revealed a positive improvement regarding physical health measurements. However, the changes were not significant (45).

### *Social and behavioural outcomes*

The study conducted by Rogerson *et al.* [2016] compared social outcomes of green outdoor exercise and indoor exercise and the influence on outcomes of the environment setting. There was three minutes more social interaction time in the outdoor condition than in the indoor setting. Further, this positive increase of social interaction time in the outdoor condition (in condition effect) had greater influence on the engagement of further exercise behaviours as well. However, there were non-significant associations for the measurement of intention for further exercise and in

outdoor settings (37).

Moreover, increased PA levels were observed for participants exposed to green space more frequently (38) and for a longer duration of park visits (43). When considering the social outcomes, social interaction time increased when participants engaged in more outdoor exercise than indoor exercise, which had more influence on further exercise behaviours, although there was no significant association between outdoor exercise setting and intention for further exercise (37). Improvement of social cohesion was observed among participants who visited green space more frequently (38).

## Discussion

The aim of this literature review was to assess the impact and effectiveness of GPA on public health and wellbeing. Observations from this narrative literature review demonstrated that out of ten studies, nine articles discussed at least one mental or physical health and wellbeing outcome interconnected with GPA. Five of the selected articles in this review, (37,39,42,44) investigated GPA and its direct influence on health and wellbeing outcomes, while three articles (41,45,46) measured the effectiveness of current green interventions which incorporated GPA related activities. Another study analyzed the health and wellbeing benefits of elderly people comparatively who access blue and green spaces, in which improved mental and physical health benefits were observed in the elderly who had higher duration of stay in parks and levels of PA (43). Out of 10 studies, two studies investigated the association between green space and health and wellbeing (38,43). As assessed, the main health and wellbeing outcomes were the mental health outcome. As far as a possible psychological health outcome is concerned, all the selected studies had assessed positive and negative impacts on mental wellbeing. Out of 10 articles, none of the articles found any results for the state of knowledge and awareness of green physical activities among participants. Positive findings for the improvements of depression directly or positive increase of indicators (vitamin D and serotonin) related to depression after attending GPA (39,44,46). One study incorporated with vitamin D treatments (39) and one trial measured vitamin D and serotonin levels as indicators (46) to assess depression levels of women. Similar results were found in the meta-analysis reviewing the beneficial effects of gardening. The wide range of health outcomes including decrease of depression were a result of horticultural

therapy-based gardening and daily gardening practices (47).

The second common mental health benefit related to GPA was the reduction of anxiety and stress. Three studies found a statistically significant reduction in anxiety levels after participants engaged GPA (42,44,46). When considering stress, another positive change for the stress level was evident in two studies that investigated the effects of an outdoor walking program (44,46). In line with this study's results, integrative literature review showed the reduction of stress in older people who engaged in nature-based activities (36). Psychological health and wellbeing of children with emotional, behavioural, and social difficulties were enhanced in one study after activities related with GE (41), while four studies among the above six, incorporated adults as participants (42,44-46). Overall, mental health wellbeing and psychological quality of life were shown in another study conducted to assess the effects of gardening activity among people with mental health issues, intellectual disabilities, patients, and healthy individuals (47).

This review found the changes in attention of participants after they engaged with GPA, such as walking and using outdoor gym equipment (cycle ergometer), and results indicated improvements in attention (37,40). Similar improvements of emotional wellbeing outcomes were observed in older adults who did nature-based activities (36). Further, one study showed no change in mood and enjoyment after outdoor exercise (37). This result for mood is inconsistent with the positive mood improvement found in a previous study (14) and improvement of enjoyment after attending GE in the study conducted by Lahart *et al.* (48).

As far as the physical and physiological health outcomes are concerned, it is observed that the physical health outcomes of hip girth, serum cholesterol, fitness and dynamic stability showed positive improvements when participants engaged with PA, none of these changes were observed more in outdoor setting than indoor setting in the study conducted by Glover *et al.* (44). Physical health parameters measured in the Park Prescription and Forest Therapy interventions showed positive improvements for adult participants (45,46).

When considering behavioural outcomes, one study investigated the compliance and adherence rate of GPA and higher compliance rate was found for group sessions than individual sessions in both indoor and outdoor conditions (44). When considering the social outcomes, positive improvement of more social interaction time was concluded in one study for outdoor exercise than indoor

exercise. Further positive changes for social interaction have a direct influence for future exercise intention as well (37).

When considering the mental health outcomes, the reduction of the prevalence of depression by 7% (38), and improved mental health outcomes (43) were observed by the long duration (30 minutes or more) of being in green space in both studies. Another study reported that green space plays an important role in relation to the improvements of mental health conditions of the people (14). Similar findings were found in the systematic review conducted by one more investigator which also observed an adequate association between life satisfaction and the amount of green space visitation, and limited association between mental health outcomes and green space visits, accessibility, and type of green space (49). Further research by another group mentioned above concluded positive changes in mental health and wellbeing of older participants who were exposed to green space (36).

Physical health status had shown a strong association with length of green space visitation, positive association with access to parks, and no association with frequency of park visits among older population. Also, there was no correlation found between cardiovascular disease and the duration of park visit. Moreover, access to parks had negative correlation with cardiovascular disease and hypertension among older people. Also, older people who had hypertension preferred to do blue space visits, while older people with cardiovascular disease preferred to visit green spaces (43).

When considering the association between green area exposure and PA levels, increased PA levels were found among participants who visited for the green spaces frequently (38) and for longer duration (43). When considering the social outcomes, positive improvement of social cohesion was concluded in one study for frequent green space exposure (38).

Forest therapy indicated significant positive changes for depression, anxiety, and mental health and wellbeing (46) while the Haven of Green Space intervention resulted in emotional wellbeing (41). In addition, the Park Prescription Intervention showed a greater improvement of psychological quality of life (45). In addition, the Park Prescription Intervention resulted in a greater significant improvement for behavioural outcomes which positively influenced the levels of GPA and contact with nature (45,46). Similar results were concluded in a different study to assess the physiological effects of Nature Therapy in Japan, which showed positive physiological effects for stress reduction with the forest therapy activities and physiological relaxation

by viewing or walking across the forest environment for 15 minutes (50).

Actual outdoor green exposure was actively experienced by the participants engaged in all ten studies. The outdoor environments included natural roads (40), diverse range of environments (river sites, conservational parks, rocks, cycling tracts, marine, and costal environments) (44) grasslands with trees (37), forests (42,46), wide range of parks (playgrounds, community parks, city parks, pocket parks, sports parks, neighbourhood parks, and regional parks) (43), outdoor parks (38,45) and outdoor gardens (41).

The most common PA type was walking, and out of nine articles, seven studies specifically indicated walking as their green activity type (39,41-46). When considering the vigorous physical activities, jogging was considered as vigorous activity type (40). In general, it is noticeable that the use of above cited physical activities and outdoor facilities is progressively increasing (weather permitted) in New Zealand population, which shows a positive sign towards achieving the Sustainable Development Goal (SDG) 4, that is about achieving good health and wellbeing for all.

## Limitations

The main limitation of this study was the narrative structure and the methodology of the study. Selection bias is the main weakness of the narrative literature review methodology. However, to reduce the bias and to increase the quality of the final 10 articles selection process, some of basic tools from the systematic literature review process were used such as PRISMA screening and CASP tools. Secondly, in this study, findings cannot be applied and generalized to the children who are aged under 18 years. The most of health and wellbeing outcomes were observed among adult populations who engaged with GPA in most studies. As the third point, none of the articles indicated findings in relation to the knowledge and awareness of GPA among participants. As the fourth limitation, physical and physiological health outcomes cannot be considered as prominent outcomes of this study and only two physiological conditions were found by this literature review.

## Conclusion and recommendations

GPA and connections with nature have been found to impact positively on the mental health and wellbeing as well as physical, physiological, behavioural, and social

wellbeing. This literature review observed and described several mental, physical, physiological, behavioural, and social outcomes that impact on health and wellbeing, associated with GPA and of the contact with nature. The most common outcome or effect is the improvements of psychological health and wellbeing of individuals. Moreover, nature-based interventions which are incorporated with GPA effectively develop mental health in a positive manner, and these programs play a significant role in behavioural change of people towards active engagement of GPA to enhance their quality of life.

The findings from this study can be recommended to be incorporated into New Zealand public health and health promotional interventions, and nature-based therapy protocols to address the high burden of chronic disease and increase physically active healthy lifestyles particularly for New Zealand population and ethnic communities which are at risk of developing chronic diseases. Further, all age groups of population must be promoted for higher engagement of GPA and contact with nature as groups to increase their social interaction and attitude and intention for further engagement in GPA. Finally, barriers to attend GPA also need to be overcome in a culturally competent way. Further studies could address a broad range of mental, physical, and physiological conditions, and health and wellbeing of children and youth related to GPA. Also, further studies need to be performed to collect data for knowledge, awareness, attitudes, perceptions, and barriers to attend in GPA.

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