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ORIGINAL ARTICLE

Need and Interest in Nature Prescriptions to Protect Cardiovascular and Mental Health: A Nationally-Representative Study With Insights for Future Randomised Trials

Thomas Astell-Burt, PhD [a,b,*], J. Aaron Hipp, PhD [c], Birgitta Gatersleben, PhD [d], Deepti Adlakha, PhD [e], Melissa Marselle, PhD [d], Katarzyna Olcoń, PhD [a], Evangelos Pappas, PhD [f], Michelle Kondo, PhD [g], Gillian Booth, PhD [h], Simon Bacon, PhD [i,j], Melissa Lem, MD [k], Monique Francois, PhD [f,l], Elizabeth Halcomb, PhD [m], Lorna Moxham, PhD [l,m,n], Patricia Davidson, PhD [o], Xiaoqi Feng, PhD [b,p,q,]**

[a]School of Health and Society, University of Wollongong, Wollongong, NSW, Australia
[b]Population Wellbeing and Environment Research Lab (PowerLab), Sydney, NSW, Australia
[c]Department of Parks, Recreation, and Tourism Management, Center for Geospatial Analytics, NC State University, Raleigh, NC, USA
[d]Environmental Psychology Research Group, School of Psychology, University of Surrey, Guildford, UK
[e]Department of Landscape Architecture and Environmental Planning, Natural Learning Initiative, College of Design, NC State University, Raleigh, NC, USA
[f]School of Medicine, University of Wollongong, Wollongong, NSW, Australia
[g]USDA Forest Service, Northern Research Station, Philadelphia Field Station, Philadelphia, PA, USA
[h]MAP Centre for Urban Health Solutions, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, ON, Canada
[i]Montreal Behavioural Medicine Centre, CIUSSS du Nord-de-l'Ile-de-Montreal, Montreal, Québec, Canada
[j]Department of Health, Kinesiology, and Applied Physiology, Concordia University, Montreal, Quebec, Canada
[k]Department of Family Practice, University of British Columbia, Vancouver, BC, Canada
[l]Illawarra Health and Medical Research Institute, Wollongong, NSW, Australia
[m]School of Nursing, University of Wollongong, Wollongong, NSW, Australia
[n]Australian Health Services Research Institute, University of Wollongong, Wollongong, NSW, Australia
[o]The Vice-Chancellor's Unit (P.M.D.), University of Wollongong, Wollongong, NSW, Australia
[p]School of Population Health, Faculty of Medicine and Health, UNSW, Sydney, NSW, Australia
[q]The George Institute of Global Health, Sydney, NSW, Australia

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Objective "Nature prescriptions" are increasingly being adopted by health sectors as an adjunct to standard care to attend to health and social needs. We investigated levels of need and interest in nature prescriptions in adults with cardiovascular diseases, psychological distress and concomitants (e.g. physical inactivity, sedentary behaviour, obesity, loneliness, burn-out).

*Corresponding author at: Professor Thomas Astell-Burt, School of Health and Society, Faculty of Arts, Social Sciences, and Humanities, University of Wollongong, Wollongong, NSW 2522, Australia; Email: thomasab@uow.edu.au; Twitter: @ProfAstellBurt

**Corresponding author at: Professor Xiaoqi Feng, School of Population Health, Faculty of Medicine and Health, University of New South Wales, Sydney, NSW, Australia; Email: xiaoqi.feng@unsw.edu.au; Twitter: @UrbanFeng

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Methods A nationally-representative survey of 3,319 adults across all states and territories of Australia was completed in February 2021 (response 84.0%). Participants were classified across 15 target groups using validated health indicators and surveyed on (1) time and frequency of visits to green and blue spaces (nature spaces), (2) interest in a nature prescription, and (3) potential confounders (e.g. age, income). Analyses were done using weighted logistic regressions.

Results The sample was 50.5% female, 52.0% were aged ≥45 years, 15.2% were living alone and 19.3% were born overseas in non-English-speaking countries. Two-thirds of the sample spent 2 hours or more a week in nature, but these levels were generally lower in target groups (e.g. 57.7% in adults with type 2 diabetes). Most participants (81.9%) were interested in a nature prescription, even among those spending fewer than 2 hours a week in nature (76.4%). For example, 2 hours a week or more in nature was lowest among sedentary adults (36.9%) yet interest in nature prescriptions in this group was still high (74.0%). Lower levels of nature contact in target groups was not explained by differences in access to or preference for local nature spaces.

Conclusions High levels of interest in nature prescriptions amid low levels of nature contact in many target health groups provides impetus for developing randomised trials of interventions that enable people to spend more time in nature. These findings can inform intervention co-design processes with a wide range of community stakeholders, end-users in target health groups, and the health professionals who support them.

Keywords Nature • Prevention • Management • Cardiovascular health • Mental health

Introduction

Increased visitation to green and blue spaces (e.g. parks and lakes) seen in some countries during the COVID-19 pandemic, such as Australia [1–3], has intensified interest in long-established benefits of nature [4]. Contact with nature mitigates harms (e.g. by regulating air quality [5]), restores depleted cognitive capacities [6,7], alleviates stress [8], reduces loneliness [9–11] and encourages regular health behaviours such as physical activity [12,13]. Meta-analyses indicate interventions that enable people to spend more time in nature increase levels of physical activity and lower risks of depression, anxiety, and high blood pressure [14], providing a compelling and urgent case to support harnessing nature in health care [15,16].

Engaging in behaviour change is complex and multifaceted involving interventions at the level of individual, community, and society. Prescribing—where there is an authoritative act of endorsement or codification of a particular agent or task—is one strategy. Nature prescriptions are emerging as a low-cost and 'green' supplement to biomedical options in many contrasting contexts [17]. Examples include the BC Parks Foundation's 'PaRx' national program in Canada [18] and the University of Wollongong's 'Recovery Camp' in Australia [19]. A review identified hundreds of other examples [20] and more are in the pipeline, with the UK in particular making substantial investments in nature therapy trials [21].

To ensure robust foundations for future trials, a number of questions need to be answered. First, if the standard recommendation to patients is to spend at least 2 hours a week in nature [18], then what percentage of patients are in need of a nature prescription and does this vary from one target population to the next? Levels of contact with nature may be different between individuals with cardiometabolic conditions and/or obesity compared with those experiencing psychological distress or its concomitants (e.g. loneliness, burn-out). While there is overlap in these conditions, the former are generally aligned with sedentary lifestyles involving long periods of time spent indoors (or in cars), whereas the latter can serve as antecedent stressful conditions prompting increased nature-seeking behaviour for psychological restoration [22].

Moreover, for each target population and, in particular, among those spending fewer than 2 hours a week in nature, it is crucial to understand what level of interest there might be for a nature prescription. Not only are populations in need often lacking geographical access to efficacious interventions [23], but levels of interest may also be lower in part due to a lack of awareness and/or understanding of the potential therapeutic benefits. Such a scenario may highlight a parallel need for equity-focussed supports that help deliver nature prescriptions to those with high potential to benefit. Our aim was to explore these issues of need and interest in nature prescriptions in the Australian context with a representative sample of adults.

Methods

Data

This study involved a survey of 4,032 participants in the Social Research Centre's *Life in Australia* panel, a nationally-representative panel spanning all states and territories of Australia including major cities and regional/rural

communities. The University of Wollongong Human Research Ethics Committee (HREC) granted ethical approval for the survey (2020/343), which was conducted between 15 February and 1 March 2021. At that time, the Australian government had relaxed COVID-19 stay-at-home orders and people were again permitted to travel and visit nature spaces with limited restrictions. A response of 84.0% resulted in a sample of 3,386 participants. Participants were aged 18 years and over and were the sole respondents from the households in which they lived. The survey was completed predominantly online with a mean duration of 19.4 minutes (3,216 participants, 84.2% response among online completers, 95.0% of the overall sample). A small number of participants elected to complete the survey via telephone at a mean interview duration of 27.2 minutes (170 participants, 80.2% response among telephone completers). This enabled participation by people without internet access or for whom online surveys were not an acceptable mode of completion. Participation was facilitated by trained interviewers in the English language only.

Outcome Variables

Responses to three survey questions were analysed. To define which participants achieved the recommended 2 hours in nature per week, we dichotomised (i.e. ≥2 hrs, <2 hrs) answers to the following question: *"Approximately how many hours did you spend in green spaces and/or blue spaces (e.g. park, reserve, woodland, beach) in total over the last 7 days?"* To supplement this, we also explored visitation of preferred local nature spaces, as these can be expected to resonate with intrinsic motivation rather than others that are less desirable. We aggregated responses to the following question: *"In the past four weeks (including the weekends), how often have you visited your preferred local green space and/or blue space?"* to either "at least once a week" or fewer.

Finally, to determine interest in a nature prescription written by a health professional, responses to the following question were coded as "likely" or "unlikely": *"How likely would you be to visit green and/or blue spaces more often if your doctor suggested it would be good for your health?"* For each question participants also had the option to respond: "Don't know/Not sure" or "Prefer not to say". Removal of participants with missing values on one or more of these questions (n=67) resulted in a final sample of 3,319.

Defining Target Populations

The survey used a wide range of questions to identify 15 target health groups for future randomised trials with strong potential to benefit from nature prescriptions. These target health groups were pre-determined before conducting the statistical analyses and are based on health priority foci and related factors known to have substantial impacts on health, but for which there are few effective interventions (e.g. loneliness). Here, we provide a description of these groups, with the wording of specific questions reported in Supplementary Table 1. Nature prescriptions could augment existing exercise-focussed interventions for management of cardiometabolic diseases and reducing obesity [15]. We identified doctor-diagnosed (Group [G] 1) cardiovascular diseases, stroke (G2), hypertension (G3), type 2 diabetes (G4), and perceived overweight (G5). Cardiometabolic diseases were measured using a question from the 45 and Up Study [24]. Perceived overweight was measured using a question on perception of overweight [25] that is correlated with BMI [26]. Nature prescriptions might also permit an intrinsically motivating remedy for sedentary behaviour (G6) and physical inactivity (G7), both measured using responses from a validated single-item question [27]. Sedentary behaviour was defined as zero days a week of physical activity. Physical inactivity was defined as fewer than 5 days a week of physical activity of ≥30 minutes.

Another strong area for application of nature prescriptions is in mental health and its concomitants, including loneliness, sleep, burn-out, and general health. We used the K6 Psychological Distress Scale [28] with scores ≥13 identifying participants experiencing (8) psychological distress (G8). Overall loneliness (G9), social loneliness (G10), and emotional loneliness (G11) were measured using the 6-item De Jong Gierveld scale [29]. Social and emotional loneliness were identified by participants scoring three points on each scale, respectively. Overall loneliness was defined by participants scoring at least three points on either scale. Insufficient sleep—≤6 hrs a night—(G12) and poor sleep quality (G13) were defined from the Pittsburgh Sleep Quality Index [30]. Burn-out (G14) was measured using a question from the stress-related Exhaustion Disorder (s-ED) scale [31]. Participants with not good general health (G15) were also measured using a question from the 45 and Up Study [24].

Confounders

Confounders included walkable access to a nature space and whether the nearest green/blue space to their home is preferable. These were measured using the questions: *"How long would it take for you to walk to the nearest green space and/or blue space from your home?"* and *"Is the green space and/or blue space nearest your home the one you prefer to visit locally and most often?"*. Other demographic and socioeconomic sources of confounding were taken into account including: sex; age; country of birth (differentiating between English-speaking and non-English-speaking); relationship status; urban/rural; highest educational attainment; annual household income; perceived financial insecurity; employment status; and the Socio-Economic Index for Areas (SEIFA) area disadvantage scale.

Statistical Analysis

Percentages and 95% confidence intervals (95% CI) were used to describe each variable. Weighted logistic regressions were used to assess associations between the health states and risk factors with each of the three outcome variables, adjusted for confounding. Models were run separately for each target population, contrasting with their healthier counterparts. Further analysis was conducted to examine

Table 1 Characteristics of the study sample, weighted for national representativeness.

N	3,319
Target Groups	% (95%CI)
Cardiovascular diseases	6.4 (5.6 to 7.4)
Stroke	2.2 (1.7 to 2.8)
Hypertension	25.7 (23.9 to 27.6)
Type 2 diabetes	5.9 (5.0 to 6.8)
Perceived overweight	39.7 (37.6 to 42.0)
Sedentary behaviour	18.5 (16.8 to 20.4)
Physical inactivity	67.5 (65.3 to 69.6)
Psychological distress	9.9 (8.6 to 11.4)
Overall loneliness	40.3 (38.1 to 42.6)
Social loneliness	34.3 (32.1 to 36.5)
Emotional loneliness	18.3 (16.5 to 20.2)
Insufficient sleep	11.2 (10.0 to 12.7)
Poor sleep quality	36.3 (34.1 to 38.5)
Burn-out	44.7 (42.4 to 47.0)
General health not good	21.8 (20.0 to 23.7)
Contact With Nature and Nature Prescriptions (Outcomes)	
Time in any nature setting >=2 hours/week	66.0 (63.8 to 68.2)
Visit preferred nature setting >=1/week in last 4 weeks	43.8 (41.5 to 46.1)
Openness to a nature prescription from a doctor	81.9 (80.1 to 83.6)
Sociodemographic Characteristics	
Woman	50.5 (48.2 to 52.8)
Age >=45 years	52.0 (49.6 to 54.3)
Born overseas, non-English-speaking country	19.3 (17.4 to 21.3)
Born overseas, English-speaking country	14.7 (13.1 to 16.4)
Speak English only	79.5 (77.4 to 81.6)
Living alone	15.2 (13.8 to 16.8)
Urban	67.0 (64.8 to 69.1)
No university degree	72.2 (70.4 to 73.9)
Annual household income <$50,000/year	27.9 (26.0 to 30.0)
Perceived financial difficulty	12.7 (11.3 to 14.3)
Unemployed	11.9 (10.3 to 13.9)
Disadvantaged area quintiles 4–5	36.9 (34.7 to 39.2)
Nearest nature >20 min walk away*	6.8 (5.7 to 8.1)
Nearest nature preferred*	54.3 (52.0 to 56.6)

Models weighted for national representativeness.
Sedentary behaviour: 30 minutes MVPA on 0 days/week.
Physical inactivity: 30 minutes MVPA on <5 days/week.
Psychological distress: Kessler 6 Distress Scale score >19.
Burn-out: Physical and emotional exhaustion.
Insufficient sleep: <6 hours/night.
*also secondary outcomes in supplementary analyses.
Abbreviations: 95%CI, 95% confidence interval; MVPA, moderate to vigorous physical activity.

how levels of interest in nature prescriptions varied with respect to current nature time within each target population. Supplementary analyses involved testing associations between health states and risk factors with (1) proximity to the nearest nature space, and (2) preference for the nearest nature space. Response propensity weights were constructed by the Social Research Centre using logistic regression to limit the impact of non-participation on representativeness of the sample. All analyses were conducted in Stata v14 (StataCorp, College Station, TX, USA) using response propensity weights constructed by the Social Research Centre (see Supplementary Text).

Results

The sample (Table 1) was 50.5% female, 52.0% were aged ≥45 years, 15.2% were living alone and 19.3% were born overseas in non-English-speaking countries. Prevalence of self-reported cardiovascular diseases, stroke, hypertension and type 2 diabetes were 6.4%, 2.2%, 25.7% and 5.9%, respectively. Approximately 40% of participants perceived themselves as overweight, 18.5% were sedentary and 67.5% were physically inactive; 9.9% experienced psychological distress and 40.3% were lonely, with levels of social and emotional loneliness at 34.3% and 18.3%, respectively. Insufficient sleep affected 11.2%, and 36.3% reported poor quality sleep. About 45% felt burnt out and 21.8% reported their general health was not good.

Two-thirds of the sample spent 2 hours or more a week in nature, but only 43.8% had visited their preferred local nature spaces at least once a week in the last month. Most participants (81.9%) were interested in a nature prescription. Nearly 7% reported no nature spaces within a 20-minute walk, but 54.3% of respondents indicated a preference for the nearest nature to their homes. Individuals spending fewer than 2 hours a week in nature, in comparison with those achieving the recommended level, reported markedly lower visitation of preferred local nature spaces (12.2% vs 60.0%) and comparatively lower—though still a generally high level of—interest in nature prescriptions (76.4% vs 84.7%). They were also slightly more likely to report no nature spaces within a 20-minute walk (8.4% vs 6.0%) and were less likely to prefer nearby nature spaces (45.7% vs 58.7%).

Recommended time spent in nature within target populations

Table 2 reports Adjusted Odds Ratios (AOR) of achieving at least 2 hours a week in nature in each target population. For example, the AOR of 0.78 indicated people with hypertension had 22% lower odds of achieving this recommended level than those without hypertension. Similar results were found for people with type 2 diabetes (34%↓), perceived overweight (25%↓), sedentary behaviour (77%↓), physical

Table 2 Weighted logistic regressions adjusted for confounding, estimating the odds of spending at least 2 hours in any nature setting in the last 7 days.

Target Groups	% (95%CI) Meeting the Nature Time Standard in the Target Group	% (95%CI) Meeting the Nature Time Standard in the Non-Target Group	AOR (95%CI)	P-value
Cardiovascular diseases	65.7 (58.4 to 72.3)	66.1 (63.7 to 68.3)	0.87 (0.61 to 1.23)	0.433
Stroke	72.2 (60.3 to 81.6)	65.9 (63.6 to 68.1)	1.48 (0.87 to 2.53)	0.149
Hypertension	63.6 (59.7 to 67.3)	66.9 (64.2 to 69.5)	0.78 (0.62 to 0.97)	0.026
Type 2 diabetes	57.7 (50.1 to 65.0)	66.5 (64.2 to 68.8)	0.66 (0.47 to 0.95)	0.023
Perceived overweight	62.1 (58.8 to 65.3)	68.6 (65.6 to 71.5)	0.75 (0.61 to 0.91)	0.004
Sedentary behaviour	36.9 (32.0 to 42.1)	72.9 (70.6 to 75.1)	0.23 (0.17 to 0.29)	<0.001
Physical inactivity	58.8 (56.0 to 61.5)	82.4 (79.0 to 85.2)	0.31 (0.24 to 0.40)	<0.001
Psychological distress	57.7 (50.2 to 64.9)	67.0 (64.6 to 69.2)	0.78 (0.55 to 1.11)	0.162
Overall loneliness	60.7 (57.0 to 64.3)	69.6 (66.8 to 72.2)	0.76 (0.61 to 0.94)	0.011
Social loneliness	60.2 (56.2 to 64.1)	69.0 (66.4 to 71.6)	0.75 (0.61 to 0.93)	0.009
Emotional loneliness	59.8 (54.0 to 65.2)	67.4 (65.0 to 69.7)	0.86 (0.65 to 1.12)	0.259
Insufficient sleep	60.1 (53.9 to 66.0)	66.9 (64.5 to 69.2)	0.84 (0.63 to 1.12)	0.242
Poor sleep quality	62.7 (59.1 to 66.2)	67.9 (65.0 to 70.6)	0.88 (0.71 to 1.08)	0.231
Burn-out	62.8 (59.4 to 66.1)	68.7 (65.7 to 71.5)	0.83 (0.67 to 1.03)	0.092
General health not good	54.7 (49.9 to 59.3)	69.2 (66.7 to 71.6)	0.58 (0.45 to 0.73)	<0.001

Sedentary behaviour: 30 minutes MVPA on 0 days/week.
Physical inactivity: 30 minutes MVPA on <5 days/week.
Psychological distress: Kessler 6 Distress Scale score >19.
Insufficient sleep: <6 hours/night.
Burn-out: physical and emotional exhaustion.
Models for each health/circumstance variable fitted separately.
Percentages and logistic regressions weighted for national representativeness.
Models adjusted for: sex, age, country group of birth, language spoken at home, household structure, urban/rural, highest educational qualification, annual household income, perceived financial circumstances, unemployment status, area-level disadvantage, walking time to nearest natural setting, preference for nearest natural setting.
Abbreviations: AOR, adjusted odds ratio; 95%CI, 95% confidence interval; MVPA, moderate to vigorous physical activity.

inactivity (69%↓), overall loneliness (24%), social loneliness (25%↓), or not good general health (42%↓).

Regular visitation of preferred local nature spaces within target populations

Table 3 reports AORs of visiting a preferred local nature space at least once a week in each of the 4 weeks prior to the survey in each target population. For example, the AOR of 0.79 indicated people with hypertension had 21% lower odds of achieving this level of interaction with their preferred local nature space, in comparison to their peers without hypertension. Similar results were also reported for people with perceived overweight (37%↓), sedentary behaviour (82%↓), physical inactivity (65%↓), psychological distress (51%↓), overall loneliness (35%↓), social loneliness (30%↓), emotional loneliness (40%↓), insufficient sleep (28%↓), poor quality sleep (↓36%), burn-out (30%↓), or not good general health (55%↓).

Interest among target populations in a nature prescription

Table 4 reports AORs for interest in nature prescriptions in each target population. For example, the AOR of 0.59 indicated people who were sedentary had 41% lower odds of interest in a nature prescription, in comparison with their counterparts who were not sedentary. Similar was found for individuals who were physically inactive (29%↓), experiencing psychological distress (32%↓), overall loneliness (30%↓), social loneliness (34%↓), or not good general health (27%↓).

Interest in a nature prescription within target populations stratified by nature time

Table 5 reports AORs for interest in nature prescriptions within each target population, stratified by time spent in nature. Sample sizes for these analyses are also reported as they involve subsets of the full sample. For example, the AOR of 0.35 indicated that among people with cardiovascular diseases (n=273), those spending less than 2 hours per week in nature had 65% lower odds of interest in a nature prescription, compared to those spending 2 hours per week or more in nature. Similar results were found for people with stroke (92%↓), hypertension (41%↓), perceived overweight (42%↓), physical inactivity (27%↓), overall loneliness (32%↓), social loneliness (40%↓), poor sleep quality (38%↓), burn-out (39%↓), or not good general health (59%↓).

Table 3 Weighted logistic regressions adjusted for confounding, estimating the odds of visiting a preferred nature setting at least once a week in each of the last 4 weeks.

Target Groups	% (95%CI) Visiting Preferred Nature in the Target Group	% (95%CI) Visiting Preferred Nature in the Non-Target Group	AOR (95%CI)	P-value
Cardiovascular diseases	47.2 (40.0 to 54.5)	43.6 (41.2 to 45.9)	0.93 (0.67 to 1.28)	0.650
Stroke	49.5 (37.4 to 61.7)	43.7 (41.4 to 46.0)	1.14 (0.70 to 1.87)	0.592
Hypertension	43.8 (40.0 to 47.7)	43.8 (41.0 to 46.5)	0.79 (0.64 to 0.98)	0.030
Type 2 diabetes	38.0 (30.7 to 45.8)	44.1 (41.8 to 46.5)	0.71 (0.48 to 1.06)	0.092
Perceived overweight	38.0 (34.7 to 41.4)	47.6 (44.5 to 50.7)	0.63 (0.52 to 0.77)	<0.001
Sedentary behaviour	15.9 (12.7 to 19.7)	50.8 (48.2 to 53.4)	0.18 (0.14 to 0.24)	<0.001
Physical inactivity	35.6 (33.0 to 38.4)	63.2 (59.2 to 67.0)	0.35 (0.28 to 0.43)	<0.001
Psychological distress	26.1 (20.4 to 32.7)	45.7 (43.3 to 48.1)	0.49 (0.34 to 0.70)	<0.001
Overall loneliness	35.7 (32.3 to 39.2)	49.3 (46.4 to 52.3)	0.65 (0.53 to 0.79)	<0.001
Social loneliness	36.6 (33.0 to 40.5)	47.5 (44.7 to 50.4)	0.70 (0.57 to 0.87)	0.001
Emotional loneliness	30.4 (25.3 to 36.0)	46.8 (44.3 to 49.3)	0.60 (0.46 to 0.80)	<0.001
Insufficient sleep	35.2 (29.5 to 41.4)	44.9 (42.5 to 47.4)	0.72 (0.54 to 0.97)	0.029
Poor sleep quality	35.7 (32.2 to 39.3)	48.4 (45.5 to 51.3)	0.64 (0.52 to 0.78)	<0.001
Burn-out	37.6 (34.3 to 41.1)	48.8 (45.7 to 51.8)	0.70 (0.57 to 0.86)	0.001
General health not good	28.7 (24.8 to 33.0)	48.0 (45.4 to 50.6)	0.45 (0.36 to 0.57)	<0.001

Sedentary behaviour: 30 minutes MVPA on 0 days/week.
Physical inactivity: 30 minutes MVPA on <5 days/week.
Psychological distress: Kessler 6 Distress Scale score >19.
Insufficient sleep: <6 hours/night.
Burn-out: physical and emotional exhaustion.
Models for each health/circumstance variable fitted separately.
Percentages and logistic regressions weighted for national representativeness.
Models adjusted for: sex, age, country group of birth, language spoken at home, household structure, urban/rural, highest educational qualification, annual household income, perceived financial circumstances, unemployment status, area-level disadvantage, walking time to nearest natural setting, preference for nearest natural setting.
Abbreviations: AOR, adjusted odds ratio; 95%CI, 95% confidence interval; MVPA, moderate to vigorous physical activity.

Supplementary analyses

Differences in perceived access to and preference for local nature were assessed for each target population, adjusted for confounders (Supplementary Tables 2 and 3). There was no statistically significant evidence that people in target populations were more likely to perceive an absence of nature spaces within a 20-minute walk, except for participants experiencing emotional loneliness (AOR=1.65; 95% CI=1.07–2.55). There was slightly more evidence that most target populations had lower odds of preferring local nature spaces. These were for individuals with sedentary behaviour (27%↓), physical inactivity (19%↓), social loneliness (23%↓), and poor sleep quality (19%↓).

Discussion

Our findings indicate a demonstrable need and interest in nature prescriptions in Australia. One third of adults spend fewer than 2 hours per week in nature and 82% report interest in nature prescriptions. Importantly, there is a high level of interest in nature prescriptions in adults spending fewer than 2 hours a week in nature (76.4%). High interest was also evident in most target populations and, notably, for the nearly one-in-five adults classified as sedentary, with three-in-four of them reporting interest in nature prescriptions. This is very positive as only 36.9% of sedentary adults achieved 2 hours per week or more in nature and just 15.9% reported regular visitation to preferred local nature spaces; the lowest levels of all 15 target health groups. Levels of interest in nature prescriptions were particularly high (≥80%) among adults with cardiovascular diseases, those who perceived themselves as overweight, physically inactive or burnt out. This interest remained above two-thirds within all target groups not meeting the recommended level of time in nature, except for stroke survivors at 58.9%.

Meanwhile, it is noteworthy that levels of interest were still reasonably high (>70%) in those who felt lonely or psychologically distressed. Prescribing nature may be an achievable, low/no-cost, and more acceptable adjunct intervention to care as usual (typically, pharmaceutical options) to address these often undetected, untreated, and stigmatised circumstances that harm quality of life in millions of people. The bottom line is that interest in nature prescriptions in adults is high but marked differences in contact

Table 4 Weighted logistic regressions adjusted for confounding, estimating the odds of being open to a nature prescription.

T groups	% (95%CI) Open to Nature Prescription in the Target Group	% (95%CI) Open to Nature Prescription in the Non-Target Group	AOR (95%CI)	P-value
Cardiovascular diseases	81.2 (75.1 to 86.1)	81.9 (80.0 to 83.7)	0.93 (0.63 to 1.38)	0.729
Stroke	77.1 (64.8 to 86.1)	82.0 (80.1 to 83.7)	0.82 (0.46 to 1.45)	0.493
Hypertension	82.8 (79.7 to 85.5)	81.6 (79.3 to 83.6)	1.14 (0.88 to 1.49)	0.325
Type 2 diabetes	75.8 (68.4 to 81.9)	82.3 (80.4 to 84.0)	0.68 (0.46 to 1.01)	0.056
Perceived overweight	80.8 (78.0 to 83.4)	82.6 (80.1 to 84.7)	0.96 (0.75 to 1.23)	0.759
Sedentary behaviour	74.0 (69.2 to 78.3)	83.6 (81.6 to 85.4)	0.59 (0.45 to 0.79)	<0.001
Physical inactivity	80.0 (77.7 to 82.2)	85.6 (82.7 to 88.1)	0.71 (0.54 to 0.92)	0.011
Psychological distress	75.8 (68.8 to 81.6)	82.5 (80.6 to 84.3)	0.68 (0.46 to 0.99)	0.043
Overall loneliness	78.9 (75.8 to 81.8)	84.0 (81.7 to 86.0)	0.70 (0.55 to 0.89)	0.004
Social loneliness	77.9 (74.4 to 81.0)	84.0 (81.9 to 85.9)	0.66 (0.51 to 0.85)	0.001
Emotional loneliness	79.1 (73.7 to 83.6)	82.6 (80.6 to 84.3)	0.80 (0.58 to 1.12)	0.195
Insufficient sleep	76.0 (69.9 to 81.1)	82.6 (80.7 to 84.4)	0.71 (0.50 to 1.01)	0.057
Poor sleep quality	79.1 (75.9 to 82.0)	83.5 (81.2 to 85.5)	0.80 (0.62 to 1.03)	0.079
Burn-out	79.9 (77.0 to 82.5)	83.5 (81.2 to 85.7)	0.80 (0.62 to 1.02)	0.077
General health not good	76.1 (71.7 to 79.9)	83.5 (81.5 to 85.3)	0.63 (0.48 to 0.84)	0.002

Sedentary behaviour: 30 minutes MVPA on 0 days/week.
Physical inactivity: 30 minutes MVPA on <5 days/week.
Psychological distress: Kessler 6 Distress Scale score >19.
Insufficient sleep: <6 hours/night.
Burn-out: physical and emotional exhaustion.
Models for each health/circumstance variable fitted separately.
Percentages and logistic regressions weighted for national representativeness | Models adjusted for: sex, age, country group of birth, language spoken at home, household structure, urban/rural, highest educational qualification, annual household income, perceived financial circumstances, unemployment status, area-level disadvantage, walking time to nearest natural setting, preference for nearest natural setting.
Abbreviations: AOR, adjusted odds ratio; 95%CI, 95% confidence interval; MVPA, moderate to vigorous physical activity.

with nature between target health groups indicates a need for customised interventions to ensure the implementation of nature prescriptions is optimally effective, cost-effective, equitable, sustainable and scalable across communities of contrasting needs and preferences.

This study benefits from being uniquely capable to assess need and interest in nature prescriptions across 15 target groups in a large nationally representative sample. Importantly, many individuals may appear in multiple target groups due to the clustering of underlying risk factors (e.g. some participants may be included in the target groups for heart disease, type 2 diabetes, hypertension, sedentary behaviour and physical inactivity). As such, these target groups are not independent, and it is quite possible that prescriptions for nature time could have positive synergies across multiple conditions. Future research might involve developing multiple risk factor profiles to define groups with highest potential to benefit. The study is also limited by self-report data, which may mean under-reporting of individuals living with particular health conditions (e.g. type 2 diabetes), though most questions used have been previously validated. The survey data is also of a particular time—during a period of the COVID-19 pandemic when stay-at-home orders had been relaxed but which may also explain high levels of loneliness and burn-out; conditions that may be particularly amenable to time in nature. Finally, these findings are in the Australian population and may not necessarily generalise to communities in different cultural, economic and climatic contexts; person- and place-based contingencies in the degree of benefit from contact with diverse forms of nature are expected and ought to be investigated, to enable co-design of future nature prescription interventions that maximise community health and level-up health inequities [16].

Acquisition of further information not necessarily limited to survey methodology will be beneficial to inform intervention development and randomised trials for target groups. This might include outstanding issues such as for what purpose (e.g., prevention, symptomatic relief, disease management), in what dose (by time only, or time spent in a particular activity such as walking), in what context (e.g. parks, beaches, bush), with what enablers (e.g. smartphone app, SMS reminders), and by overcoming which barriers (distance, financial cost). These issues are all key to resolve and the focus of research ought to expand from individuals to the contexts they spend time in and the health professionals that might write nature prescriptions. For instance, recent qualitative research [32] indicates high willingness to promote nature prescriptions among mental

Table 5 Weighted logistic regressions adjusted for confounding, estimating the odds of being open to a nature prescription contingent on the recommended 2 hours per week in nature.

Target Groups	N	% (95%CI) Open to Nature Prescription Among Those Not Meeting the Nature Time Standard in the Target Group	% (95%CI) Open to Nature Prescription Among Those Meeting the Nature Time Standard in the Target Group	AOR (95%CI)	P-value
Cardiovascular diseases	273	67.9 (55.4 to 78.2)	88.2 (81.5 to 92.7)	0.35 (0.16 to 0.75)	0.007
Stroke	98	58.9 (35.2 to 79.1)	84.1 (70.5 to 92.2)	0.08 (0.01 to 0.57)	0.012
Hypertension	1,059	75.7 (69.8 to 80.7)	86.9 (83.2 to 89.8)	0.59 (0.38 to 0.92)	0.021
Type 2 diabetes	258	71.0 (59.3 to 80.4)	79.2 (69.1 to 86.7)	0.71 (0.32 to 1.57)	0.391
Perceived overweight	1,408	74.6 (69.7 to 78.9)	84.7 (81.1 to 87.7)	0.58 (0.40 to 0.84)	0.004
Sedentary behaviour	598	72.3 (66.1 to 77.7)	77.0 (68.6 to 83.6)	0.71 (0.42 to 1.20)	0.201
Physical inactivity	2,163	75.4 (71.5 to 78.8)	83.3 (80.3 to 86.0)	0.63 (0.47 to 0.84)	0.002
Psychological distress	295	70.5 (60.1 to 79.1)	79.6 (69.4 to 87.0)	0.56 (0.27 to 1.16)	0.120
Overall loneliness	1,291	74.4 (69.3 to 79.0)	81.9 (77.6 to 85.5)	0.68 (0.46 to 0.99)	0.046
Social loneliness	1,130	72.0 (66.4 to 77.1)	81.7 (77.0 to 85.6)	0.60 (0.41 to 0.90)	0.012
Emotional loneliness	534	79.8 (72.9 to 85.3)	78.6 (70.7 to 84.8)	1.25 (0.66 to 2.35)	0.493
Insufficient sleep	398	72.2 (62.8 to 80.0)	78.5 (70.1 to 85.0)	0.74 (0.40 to 1.38)	0.345
Poor sleep quality	1,211	73.0 (67.7 to 77.7)	82.8 (78.5 to 86.3)	0.62 (0.43 to 0.90)	0.013
Burn-out	1,389	74.0 (69.1 to 78.3)	83.4 (79.6 to 86.5)	0.61 (0.43 to 0.86)	0.006
General health not good	755	67.2 (60.6 to 73.2)	83.4 (77.5 to 88.1)	0.41 (0.25 to 0.68)	<0.001

Sedentary behaviour: 30 minutes MVPA on 0 days/week.
Physical inactivity: 30 minutes MVPA on <5 days/week.
Psychological distress: Kessler 6 Distress Scale score >19.
Insufficient sleep: <6 hours/night.
Burn-out: physical and emotional exhaustion.
Models for each health/circumstance variable fitted separately.
Percentages and logistic regressions weighted for national representativeness.
Models adjusted for: sex, age, country group of birth, language spoken at home, household structure, urban/rural, highest educational qualification, annual household income, perceived financial circumstances, unemployment status, area-level disadvantage, walking time to nearest natural setting, preference for nearest natural setting.
Abbreviations: AOR, adjusted odds ratio; 95%CI, 95% confidence interval; MVPA, moderate to vigorous physical activity.

health clinicians, but also concerns regarding multiple barriers that may challenge implementation of nature prescriptions in people living with mental illness. One such barrier might be a lack of physical access or transport to a nature space that feels safe and with qualities that attend to an individual's preferred routines [3,9,16]. A nature prescription that applies social pressure on a person to visit a space in which they feel out of place or unsafe may be a source of distress rather than restoration [33]. Future trials will need to be multilevel, with people, places, and health care providers as triple-foci for interventions spanning efficacy, effectiveness, and implementation.

Nature prescriptions are therefore complex interventions, and their delivery is likely to involve multiple components. This is reflected in recent trials testing mixtures of components including coaching, personalised goal feedback, digital nudges via a smartphone app [34], exercise counselling, information on nearby parks, SMS messaging, and a one-hour weekly physical activity program in a park for 6 months [35]. Such complexity raises another challenge: how to disentangle the behavioural mechanisms operating in serial and parallel by which a prescription may lead to a person spending more time in nature, and thereby estimate the relative contribution of *each component* to the effectiveness of the intervention? Clearly, while all components are intended to have positive impact, some may be ineffective, or even antagonistic. For example, with parks [10] and tree canopy [11] each being longitudinally associated with reduced odds of onset loneliness, contact with nature represents a highly promising low/no cost strategy for disrupting local conditions that cause or aggravate loneliness (termed 'lonelygenic environments' [36]). However, caution is required for developing a nature prescribing intervention for loneliness in which a smartphone and/or social media is a core component of implementation, given evidence that such technologies can undermine the restorative benefits of nature contact [37] and even leave people feeling more depressed and alone [38]. Understanding "why" an intervention (and its individual components) works (or not) is important for establishing credibility, and established methods, such as the

"behaviour change wheel" [39], can help. But these key details are largely obscured in the traditional 'packaged' approach to randomised trials.

Future work testing the effectiveness of nature prescriptions and associated therapies might harness the 'Multiphase Optimisation Strategy' (MOST) strategy for developing interventions [40]. MOST provides remedies to the aforementioned pitfalls through a three-stage process of preparation, optimisation, and evaluation. The findings in our study contribute to the preparation stage, which also involves establishing a conceptual model for the intervention and then a range of projects including feasibility studies and pilot testing of interventions co-designed with community stakeholders, end-users in target health groups, and the health professionals who support them. These processes must be informed by rich understandings of local environmental conditions, some of which could be harnessed in nature prescription programs (e.g. high quality nearby nature spaces [3]), but also contextual elements that may cause harm or potentially undermine intervention effectiveness and implementation [36]. The next step is the optimisation stage, which encourages use of avant-garde study designs (e.g., a factorial experiment) to define the efficacy of specific intervention components individually or in combination for a given outcome (e.g., hours spent in nature), within a certain constraint. Accordingly, optimisation permits the discounting of components that do not contribute positively, with those remaining in the intervention evaluated in the final stage that resembles a more typical efficacy trial e.g., a two-arm randomised controlled trial.

Conclusion

In conclusion, this study has demonstrated that there are high levels of need and interest in nature prescriptions within the Australian context. This is the case even in many populations (e.g. physically inactive) that are the focus of current behavioural change interventions. By attending to common intrinsic motivations for spending time in nature, an evidence-based nature prescription system may not only help to address urgent mental, physical, and social health needs that routine medical care does not provide, but also lay foundations for sustained and equitable recovery, protection, and prevention of chronic diseases later in the lifecourse. It is crucial that as nature prescription strategies are implemented by health professionals and supporting organisations across contrasting economic, cultural, and climatic contexts that sufficient investment in community co-design and trial-based evaluation is made to ensure that decision-makers have definitive evidence of what works where, when and for whom.

Declarations of Interest

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Appendices

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.hlc.2022.11.008

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