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Bem-estar e Soluções baseadas na Natureza

Nature Based Solutions (NBS) and well-being: a threefold pathway

Marino Bonaiuto
in collaboration with Thomas Albers

Centro Interuniversitario di Ricerca in Psicologia Ambientale CIRPA

Dipartimento di Psicologia dei Processi di Sviluppo e Socializzazione

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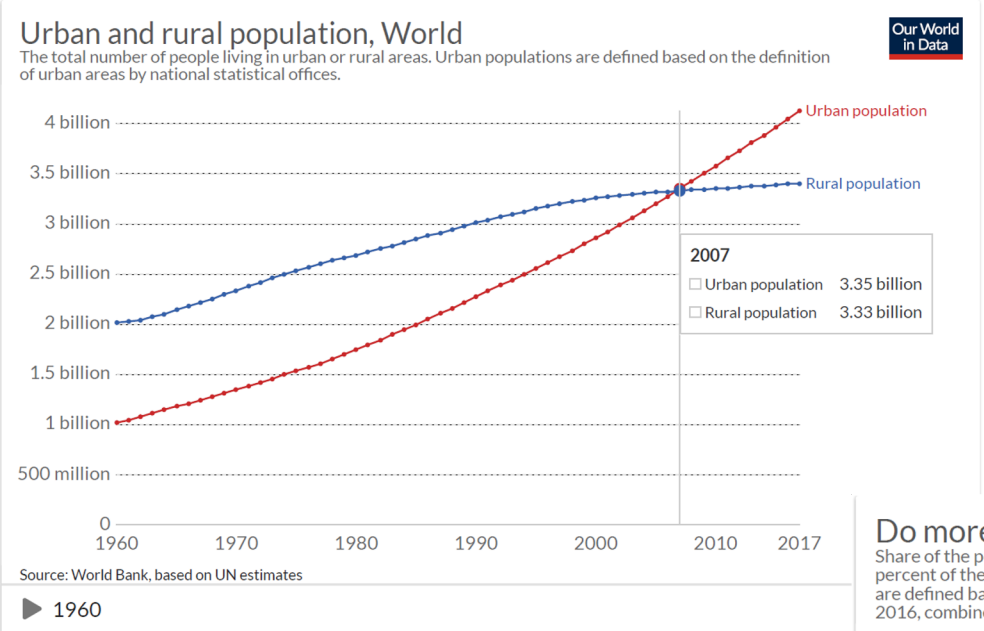
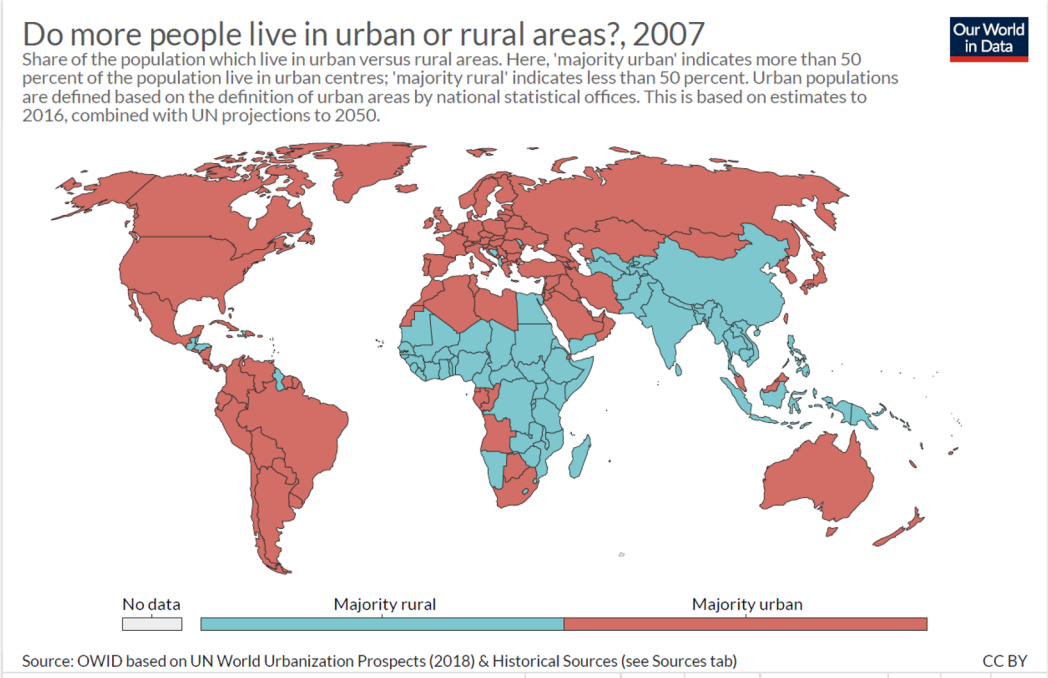
Population: urbanized vs. rural 2007

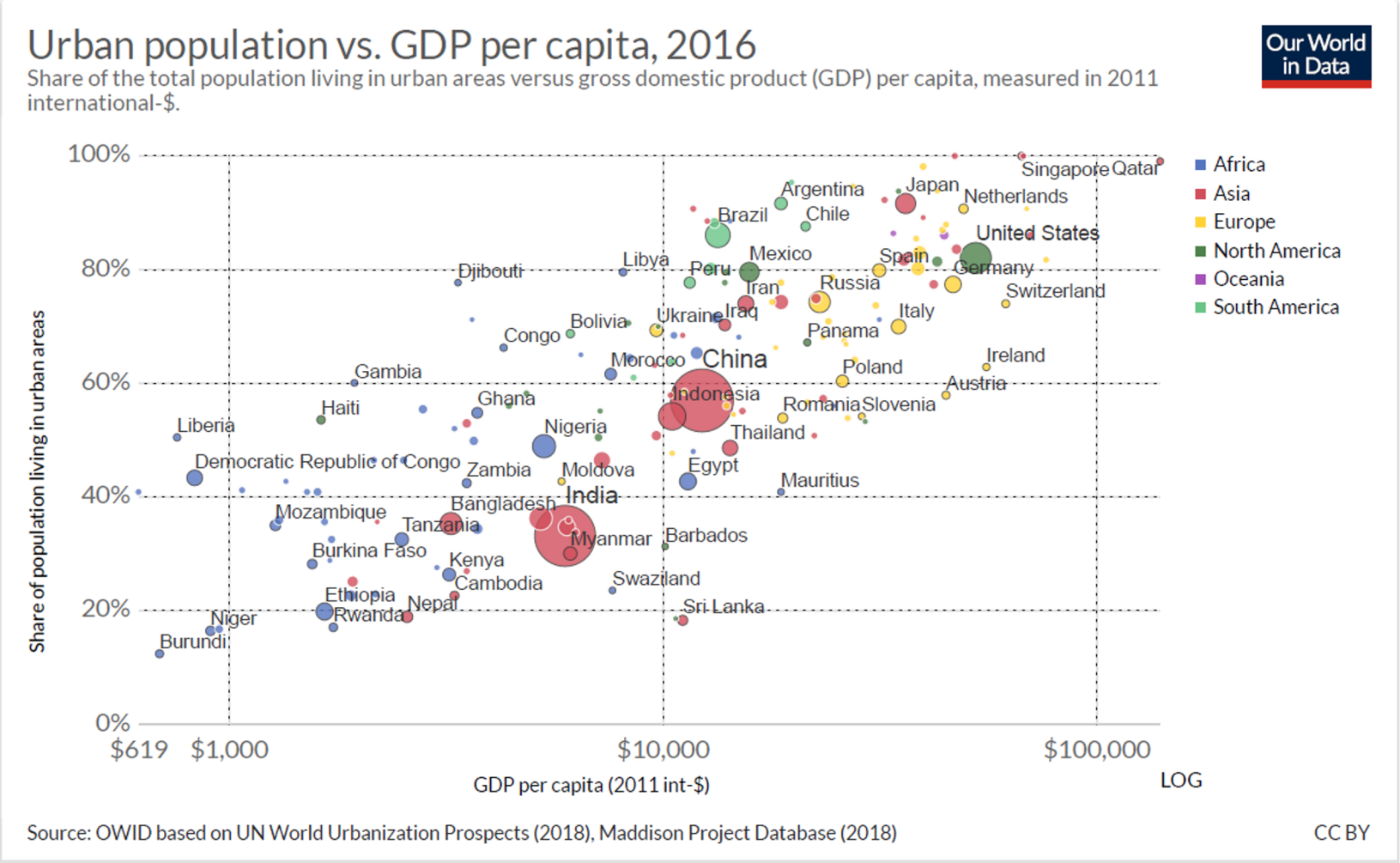
UN data and estimate (Ritchie, Roser, 2018)





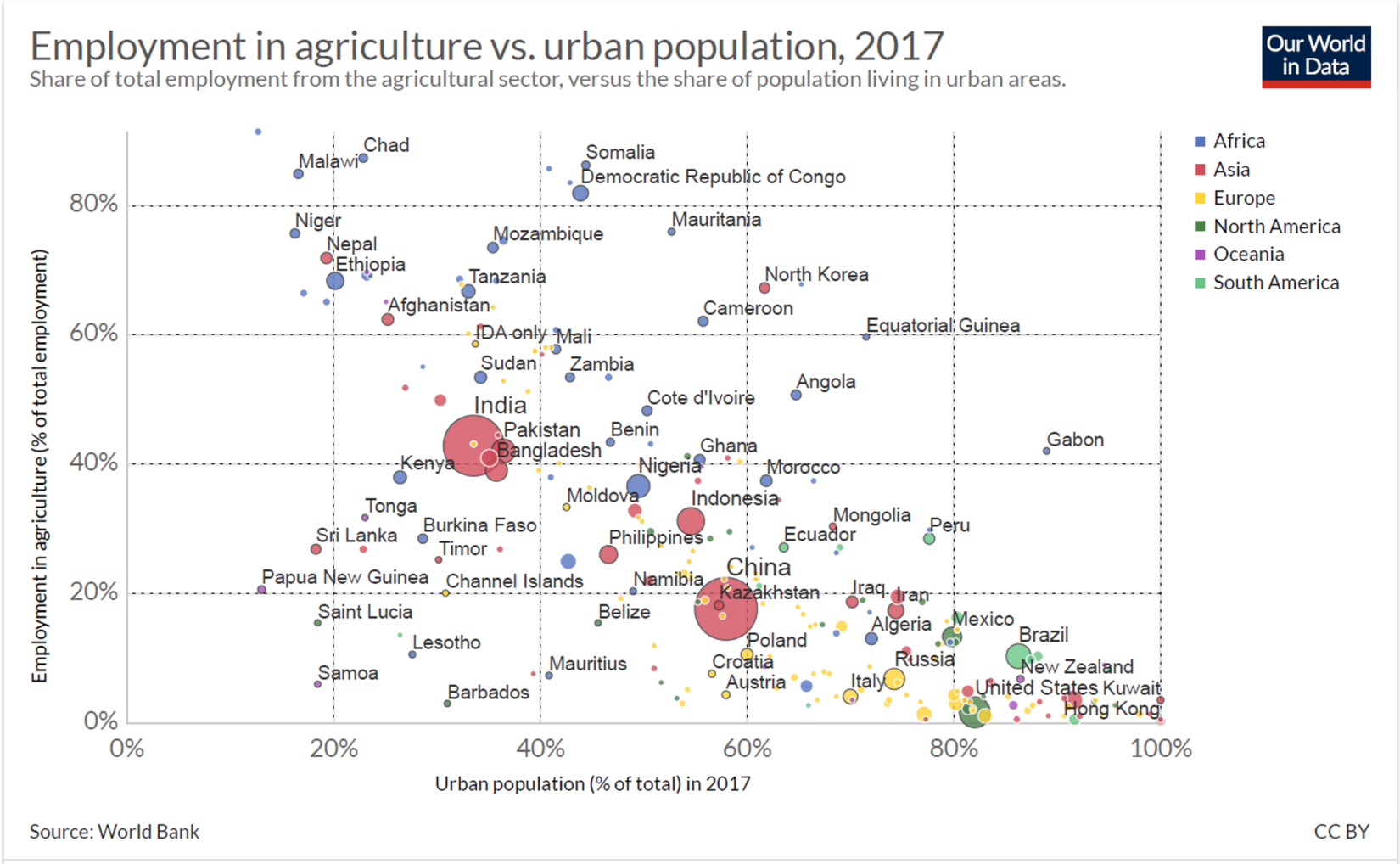
Population: urbanized and GDP per capita

UN data and estimate (Ritchie, Roser, 2018)



Population: urbanized and %agri-employed

UN data and estimate (Ritchie, Roser, 2018)



Population: urbanized and problems

Positive effects, un-evenly distributed, negative effects

1. Positive effects: “in nearly all countries electricity access is higher in urban areas than in rural areas; access to improved sanitation is higher in urban areas; access to improved drinking water is higher in urban areas; access to clean fuels for cooking and heating is higher in urban areas; child malnutrition is lower in urban settings.” Not to speak, of course, about cultural and social opportunities, from education to entertainment, as well as political and economics developments.

2. Unevenly distributed: the UN (2018) stresses that, in order to ensures that “the benefits of urbanization are shared and that no one is left behind, policies to manage urban growth need to ensure access to infrastructure and social services for all, focusing on the needs of the urban poor and other vulnerable groups for housing, education, health care, decent work and a safe environment.” (https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf). This means that urbanization per se, therefore, is not a magic wand, as it requires certain conditions to be fully successful, as well as a proper design and management to optimize its effects on both the population and the environment.

3. Negative effects as well, at many different levels of the urban system: a wide range of individually and collectively undesirable threatening consequences for urban inhabitants (e.g., from stress to un-safety for the individual), for their places (e.g., from threats to heritage sites to disruption of local communities), and for the broader environment (e.g., from energy depletion to air, water, soil pollutions, up to biodiversity threat). Pop writings about supposed “Nature-deficit disorder”, “Eco-anxiety”, “Solastalgia”, etc., still all non-officially diagnosed syndromes (e.g., in DSM terms)

Nature Based Solutions (NBS)

Green Infrastructures: e.g., NYC High Line 2006 - 2015

A nonprofit organization called Friends of the High Line[58] was formed in 1999 by Joshua David and Robert Hammond, who lived in the surrounding area. They advocated its preservation and reuse as public open space, an elevated park or greenway similar to the Promenade Plantée in Paris.[74][75][8] The organization was initially a small community group advocating the High Line's preservation and transformation when the structure was threatened with demolition during Rudy Giuliani's second term as mayor. […] Funders of the High Line park raised a total of over $150 million (equivalent to $175,174,000 in 2018).

The **High Line** is a 1.45-mile-long (2.33 km) elevated linear park, greenway and rail trail created on a former New York Central Railroad spur on the west side of Manhattan in New York City.[1] The High Line's design is a collaboration between James Corner Field Operations (Project Lead), Diller Scofidio + Renfro, and Piet Oudolf. The abandoned spur has been redesigned as a "living system" drawing from multiple disciplines which include landscape architecture, urban design, and ecology. Since opening in 2009, the High Line has become an icon of contemporary landscape architecture.

https://en.wikipedia.org/wiki/High_Line

The High Line's success has inspired cities throughout the United States to redevelop obsolete infrastructure as public space.[15] The project has spurred real estate development in adjacent neighborhoods,[16] increasing real-estate values and prices along the route in an example of the halo effect.[17] As of September 2014, the park had nearly five million visitors annually.

https://en.wikipedia.org/wiki/High_Line

NBS effects on urban health and wellbeing

e.g., Herzog & Rozado (2019, p. 14)

1. Physical
2. Psychological
3. Social

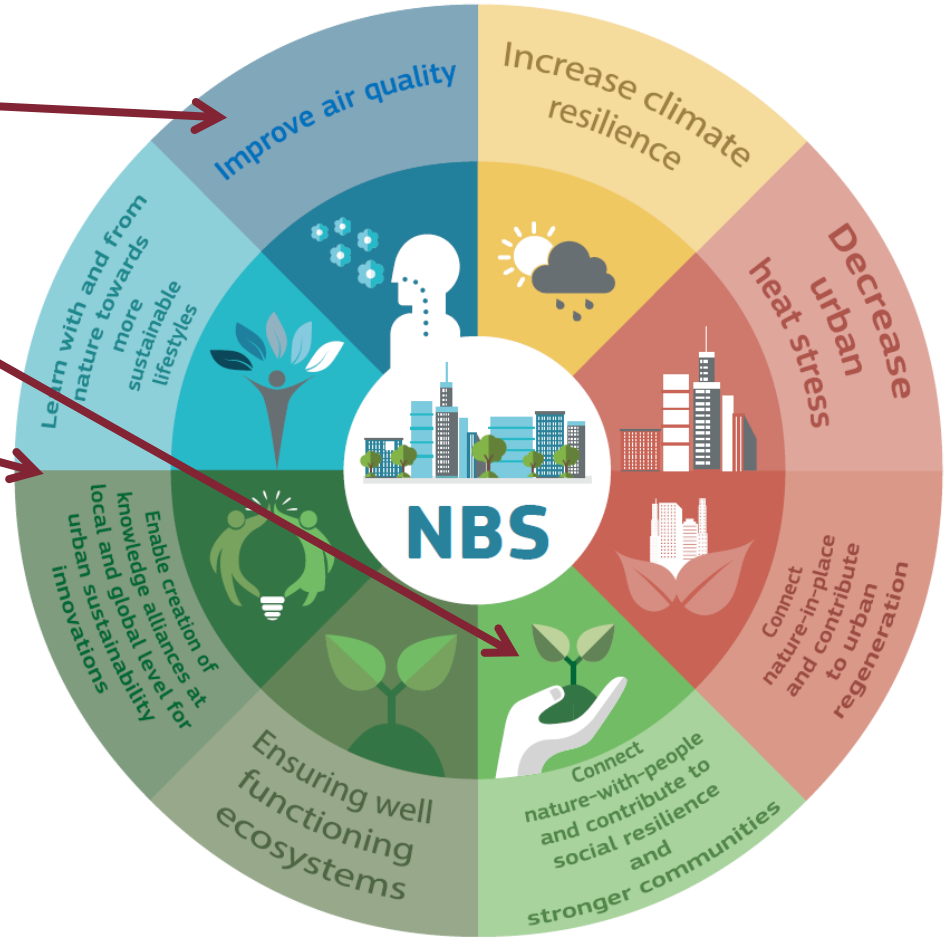
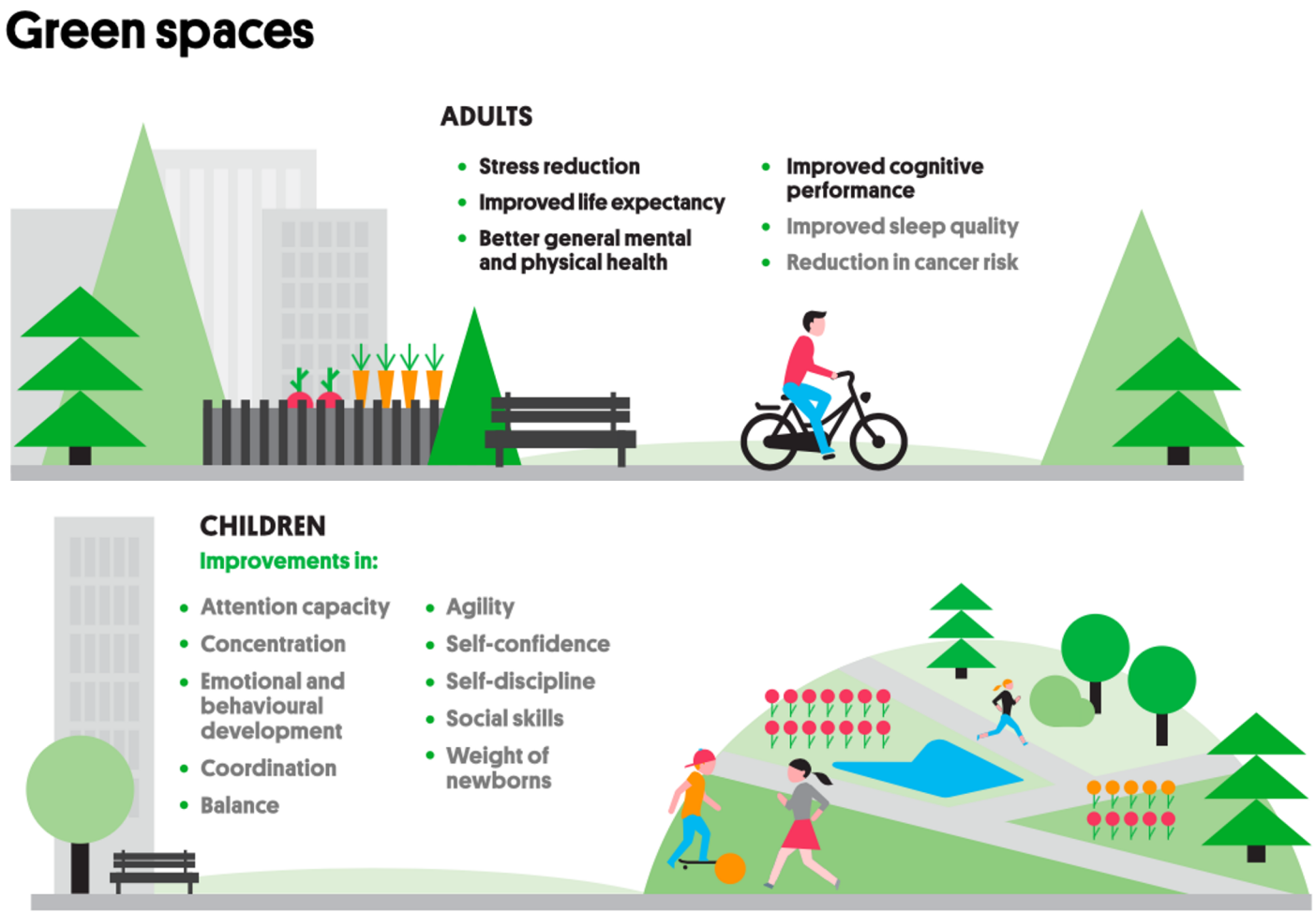


Figure 4. Examples of the multiple benefits provided by NBS.

NBS effects on urban health and wellbeing

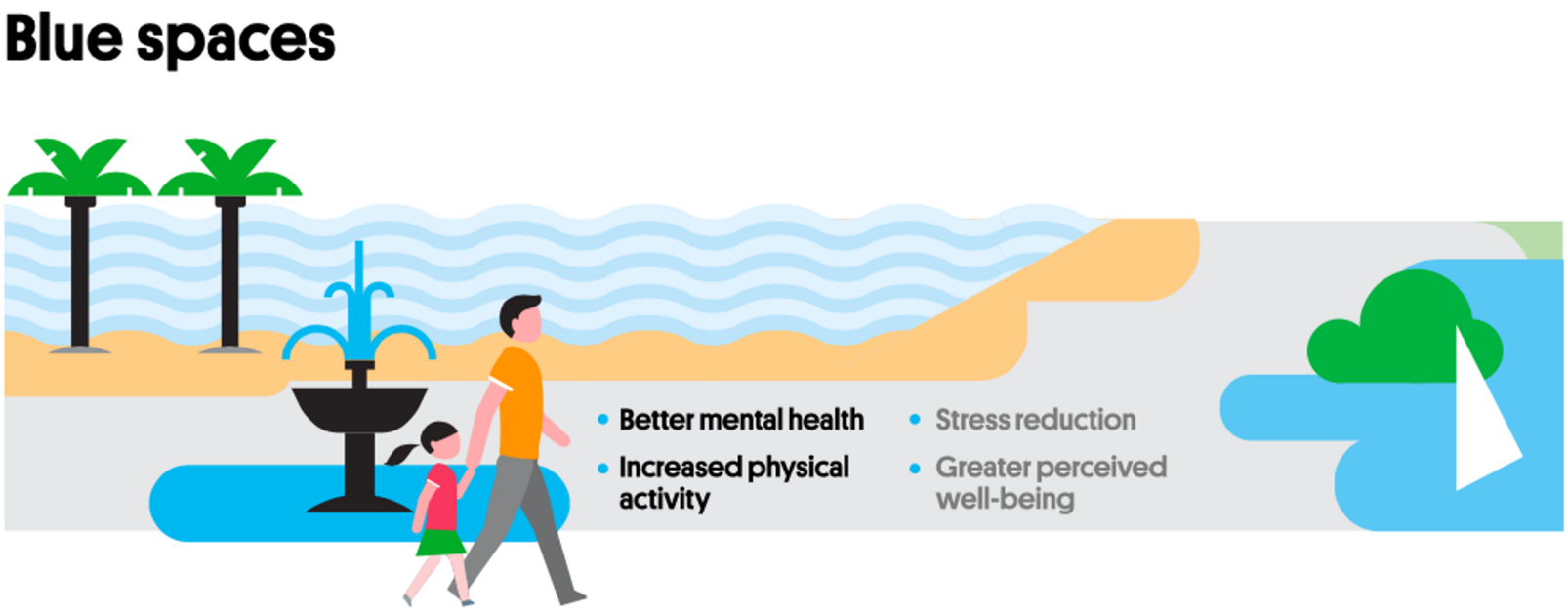
Green urban areas



Images retrieved from https://www.isglobal.org/en/ciudadesquequeremos

NBS effects on urban health and wellbeing

Blue urban spaces



Images retrieved from https://www.isglobal.org/en/ciudadesquequeremos

NBS effects mediated by the experience

Bratman et al. (2019)

SCIENCE ADVANCES | REVIEW

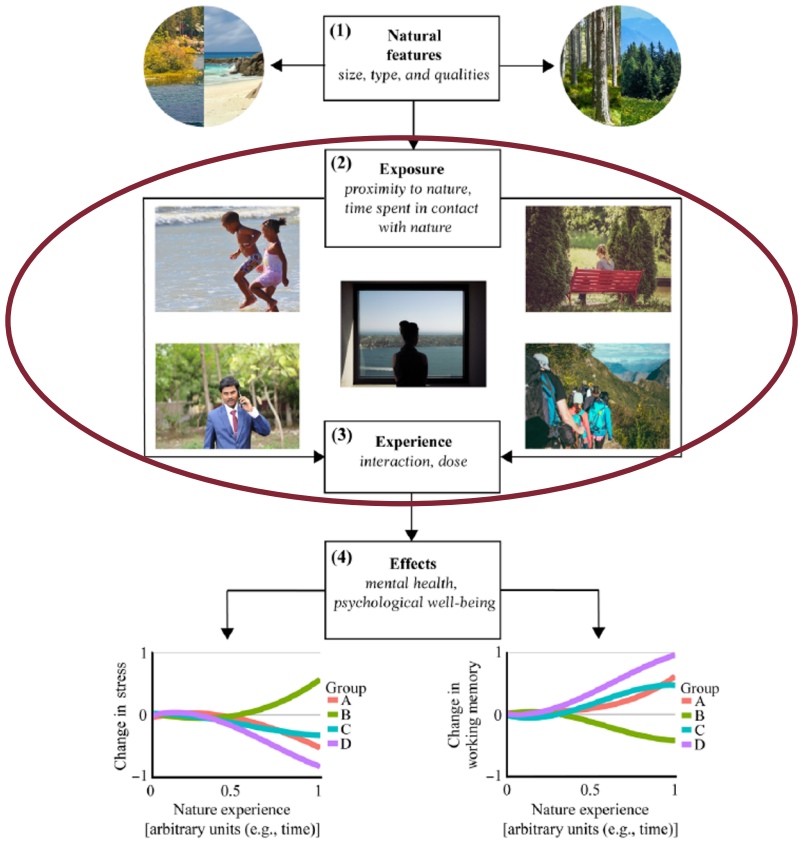


Fig. 1. A conceptual model for mental health as an ecosystem service. (1) Natural features include the characteristics (size, type, and qualities such as configuration) of the nature under consideration. (2) Exposure is estimated through methods that take proximity, likelihood, and duration of nature contact into account. (3) Experience characterizes the types, forms, and intensity of experience that exposure instantiates. (4) Effects (i.e., mental health impacts) will vary according to the moderating influences of individual differences and sociocultural context, which may affect the impact experienced by people [here represented conceptually by groups A to D (e.g., different age groups)], members of which may receive different benefits from nature experience, given these moderators. It is also possible that a group will receive a net negative effect due to individuals' aversion to urban green spaces or the negative repercussion of green gentrification in their area, for example (represented conceptually by group B). Photographs are from the public domain and free for public use.

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Nature and mental health: An ecosystem service perspective

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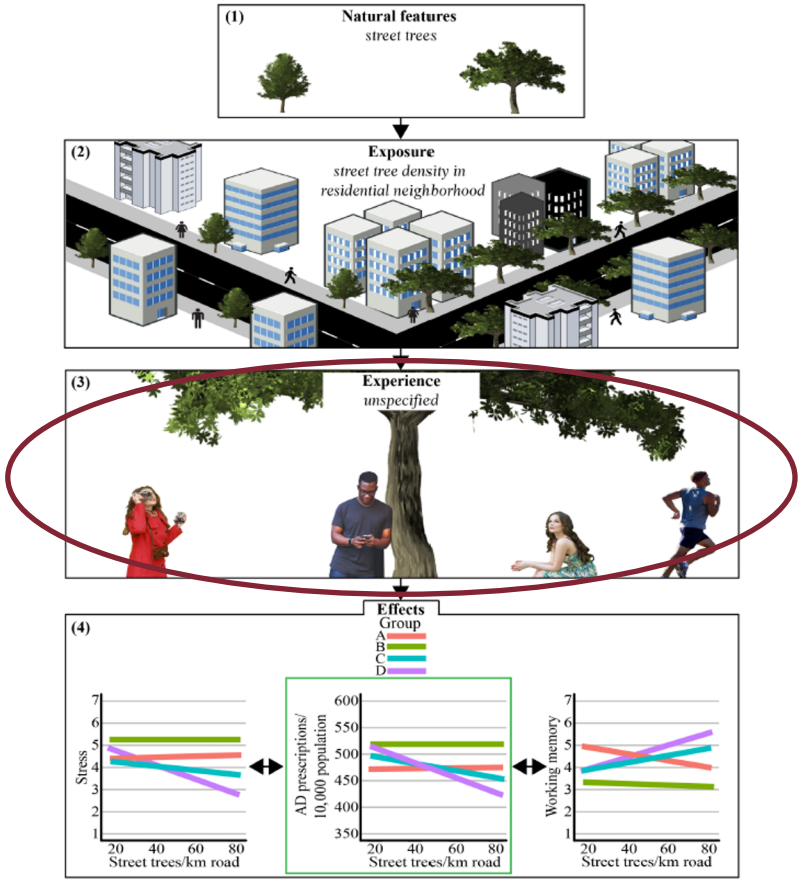

Fig. 3. A hypothetical application of the conceptual model using a case study for which antidepressant prescription is the outcome. Information is gathered for each of the three steps. (1) Natural features in this case are street trees (other characteristics unspecified, including spatial configuration). (2) Exposure is calculated using a cumulative exposure approach regarding residential street tree density (spatial configuration illustrated here for conceptual purposes but not relevant to this estimation metric). (3) Dose and/or interaction were not taken into account. (4) The effect of decreased antidepressant (AD) prescriptions in areas with more street trees is represented along with other potential benefits (e.g., stress and working memory) not projected specifically in this case, although they are represented conceptually. As illustrated in Fig. 1, different nature options provide benefits that we can quantify over and above a "no nature" version of an urban plan. The model allows us to compare net benefits (total benefits less costs) of different viable plans. Benefits will also likely vary according to the moderating influences of individual differences and sociocultural context, here represented conceptually by groups A to D, as people receive different benefits from nature experience given these moderators. Photographs are from the public domain and free for public use.

NBS experience drivers: near, nice, notable

Garrett et al. (2019) Hong Kong *n*=1,000 old adults

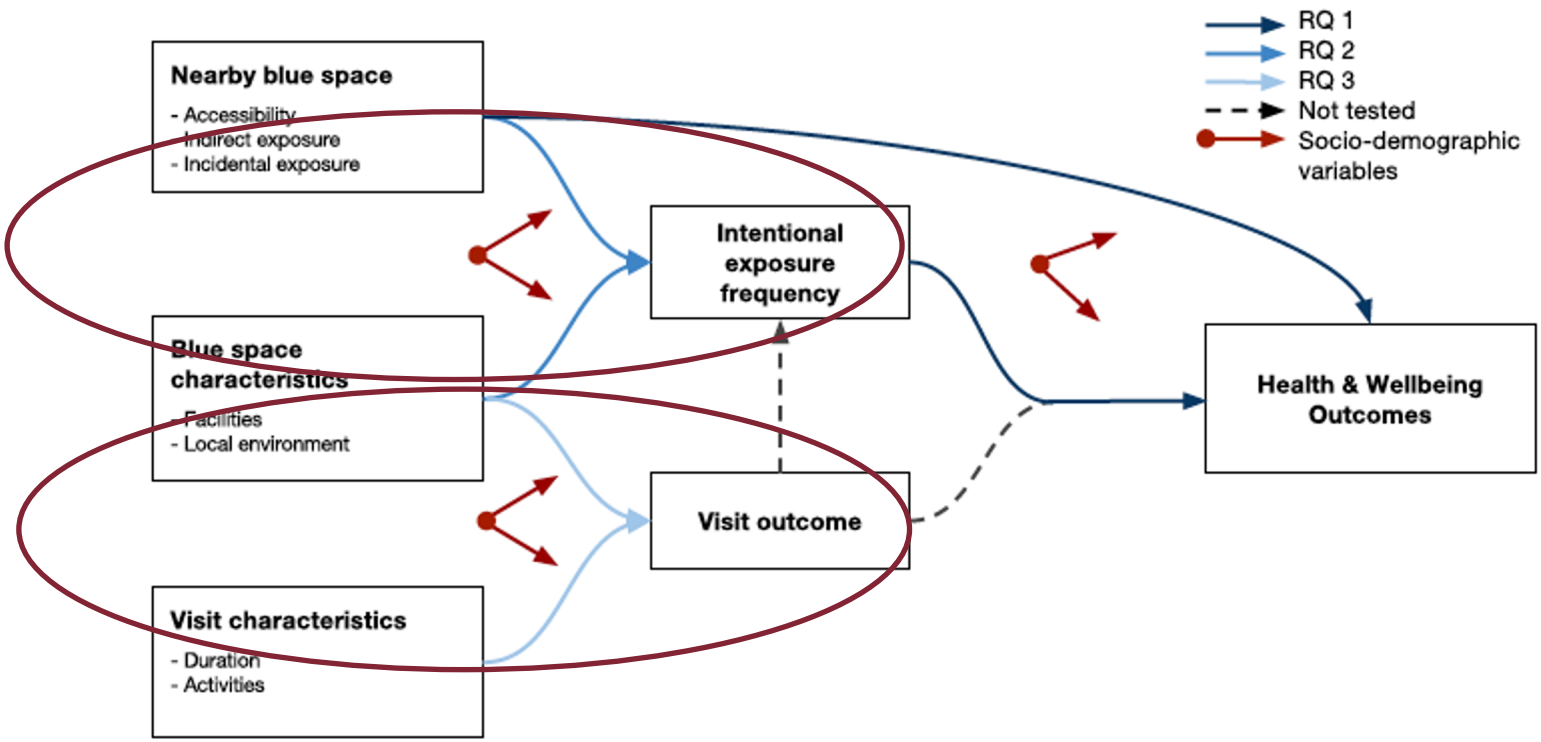

Fig. 1. Schematic of research questions (RQ) and analysis.

NBS experience drivers: near, nice, notable

Garrett et al. (2019) Hong Kong *n*=1,000 old adults

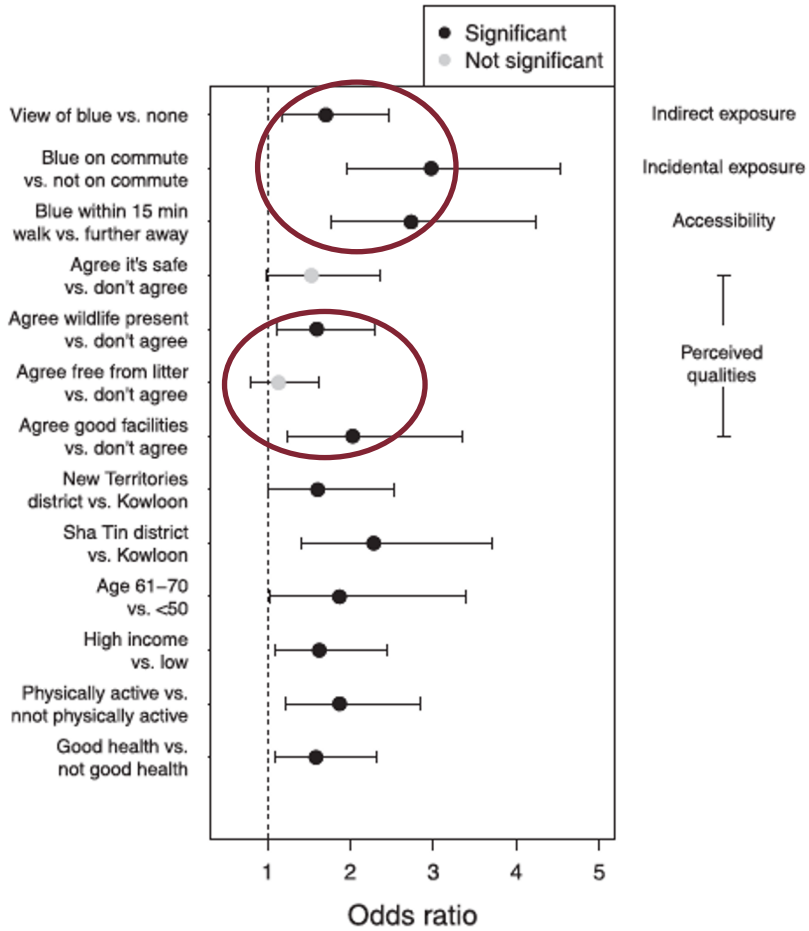

Fig. 3. Odds ratios and 95% confidence intervals for the adjusted model for factors affecting nearest blue space visit frequency (research question 2).

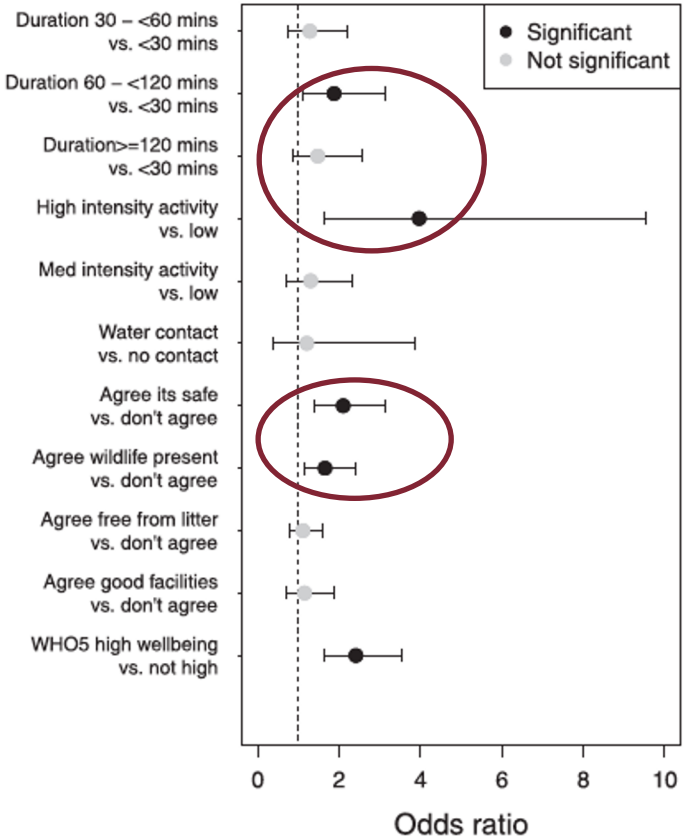

Fig. 4. Odds ratios and 95% confidence intervals for the adjusted model for factors affecting the wellbeing outcome from a single visit (research question 3).

NBS experience: a notable "dose"

White et al. (2019) UK *n*=19,806 representative sample

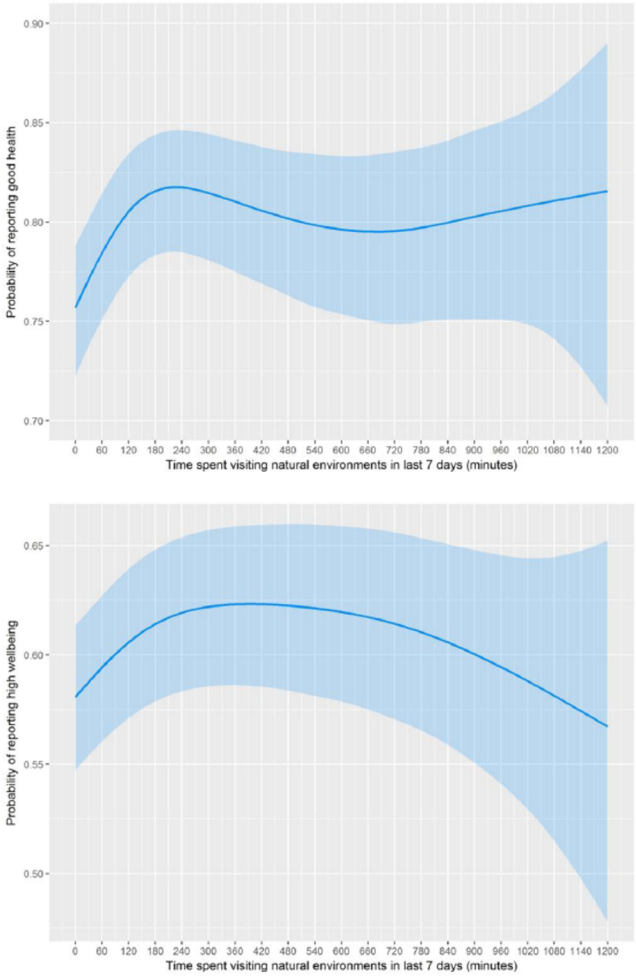

Figure 2. The probability of reporting (**a**) good health and (**b**) high well-being (with 95% confidence intervals) as a function of time spent in nature in the last 7 days using a generalised additive model (GAM) with a penalized cubic spline for nature contact. Note. The GAM is adjusted for urbanicity, neighbourhood greenspace, area deprivation, background PM10, sex, age, SES, restricted functioning, physical activity, employment status, relationship status, ethnicity, children in household, dog ownership and year.

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SCIENTIFIC REPORTS

OPEN

Spending at least 120 minutes a week in nature is associated with good health and wellbeing

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Mathew P. White[1], Ian Alcock[1], James Grellier[1], Benedict W. Wheeler[1], Terry Hartig[2], Sara L. Warber[1,3], Angie Bone[1], Michael H. Depledge[1] & Lora E. Fleming[1]

Spending time in natural environments can benefit health and well-being, but exposure-response relationships are under-researched. We examined associations between recreational nature contact in the last seven days and self-reported health and well-being. Participants (n = 19,806) were drawn from the Monitor of Engagement with the Natural Environment Survey (2014/15–2015/16); weighted to be nationally representative. Weekly contact was categorised using 60 min blocks. Analyses controlled for residential greenspace and other neighbourhood and individual factors. Compared to no nature contact last week, the likelihood of reporting good health or high well-being became significantly greater with contact ≥120 mins (e.g. 120–179 mins: ORs [95%CIs]: Health = 1.59 [1.31–1.92]; Well-being = 1.23 [1.08–1.40]). Positive associations peaked between 200–300 mins per week with no further gain. The pattern was consistent across key groups including older adults and those with long-term health issues. It did not matter how 120 mins of contact a week was achieved (e.g. one long *vs.* several shorter visits/week). Prospective longitudinal and intervention studies are a critical next step in developing possible weekly nature exposure guidelines comparable to those for physical activity.

A growing body of epidemiological evidence indicates that greater exposure to, or 'contact with', natural environments (such as parks, woodlands and beaches) is associated with better health and well-being, at least among populations in high income, largely urbanised, societies[1]. While the quantity and quality of evidence varies across outcomes, living in greener urban areas is associated with lower probabilities of cardiovascular disease[2], obesity[3], diabetes[4], asthma hospitalisation[5], mental distress[6], and ultimately mortality[7], among adults; and lower risks of obesity[8] and myopia[9] in children. Greater quantities of neighbourhood nature are also associated with better self-reported health[10–12], and subjective well-being[13] in adults, and improved birth outcomes[14], and cognitive development[15], in children.

However, the amount of greenspace in one's neighbourhood (e.g. percent of land cover in a 1 km radius from the home), or the distance of one's home to the nearest publically accessible green space or park[16] is only one way of assessing an individual's level of nature exposure. An alternative is to measure the amount of time individuals actually spend outside in natural environments[17,18], sometimes referred to as 'direct' exposure[19]. Both approaches are potentially informative. Residential proximity to nature may be related to health promoting factors such as reduced air and noise pollution (although the relationships are complex[20]); and may also provide 'indirect' exposure via views from the property[21]. Residential proximity is also generally positively related to 'direct' exposure; i.e. people in greener neighbourhoods tend to report visiting greenspace more often[22]. Yet many nature visits take place outside of the local neighbourhood[23]. Moreover, such visits may compensate for a lack of nature in the neighbourhood[24]. In other words, direct exposure, or more specifically in the current context, recreational time spent in natural environments per week, cannot accurately be inferred from neighbourhood greenspace near the home.

Using data from a representative sample of the adult population of England, we aimed to better understand the relationships between time spent in nature per week and self-reported health and subjective well-being. Our research builds directly on a small number of studies that have started to look at similar issues[17,18,25,26], and answers the call made in several recent reviews for more work in this area[27,28]. Quantification of these 'exposure-response'

[1]European Centre for Environment and Human Health, University of Exeter Medical School, Exeter, UK. [2]Institute for Housing and urban Research, Uppsala University, Box 514, SE-75120, Uppsala, Sweden. [3]Department of Family Medicine, University of Michigan Medical School, Ann Arbor, MI, USA. Correspondence and requests for materials should be addressed to M.P.W. (email: mathew.white@exeter.ac.uk)

NBS experience: a notable "dose"

White et al. (2019) UK *n*=19,806 representative sample

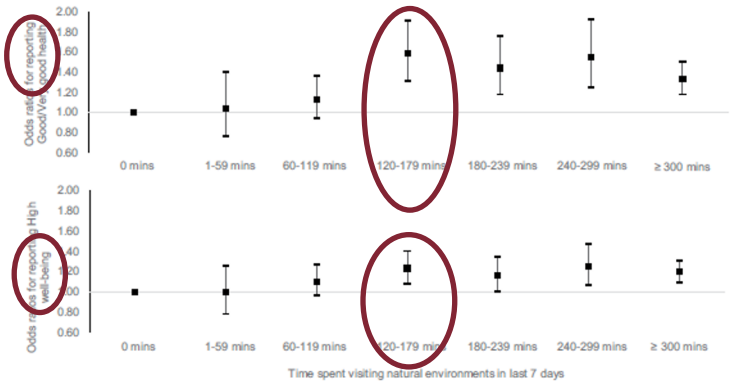


Figure 1. The odds ratios (OR) and 95% confidence intervals of reporting good health and high well-being as a function of nature visit duration in the last 7 days (0 mins = reference category). Note: Adjusted for urbanicity, neighbourhood greenspace, area deprivation, background PM10, sex, age, SES, restricted functioning, physical activity, employment status, relationship status, ethnicity, children in household, dog ownership and year.

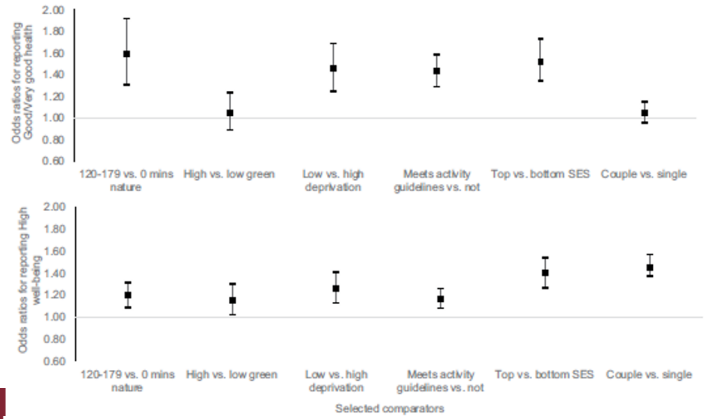
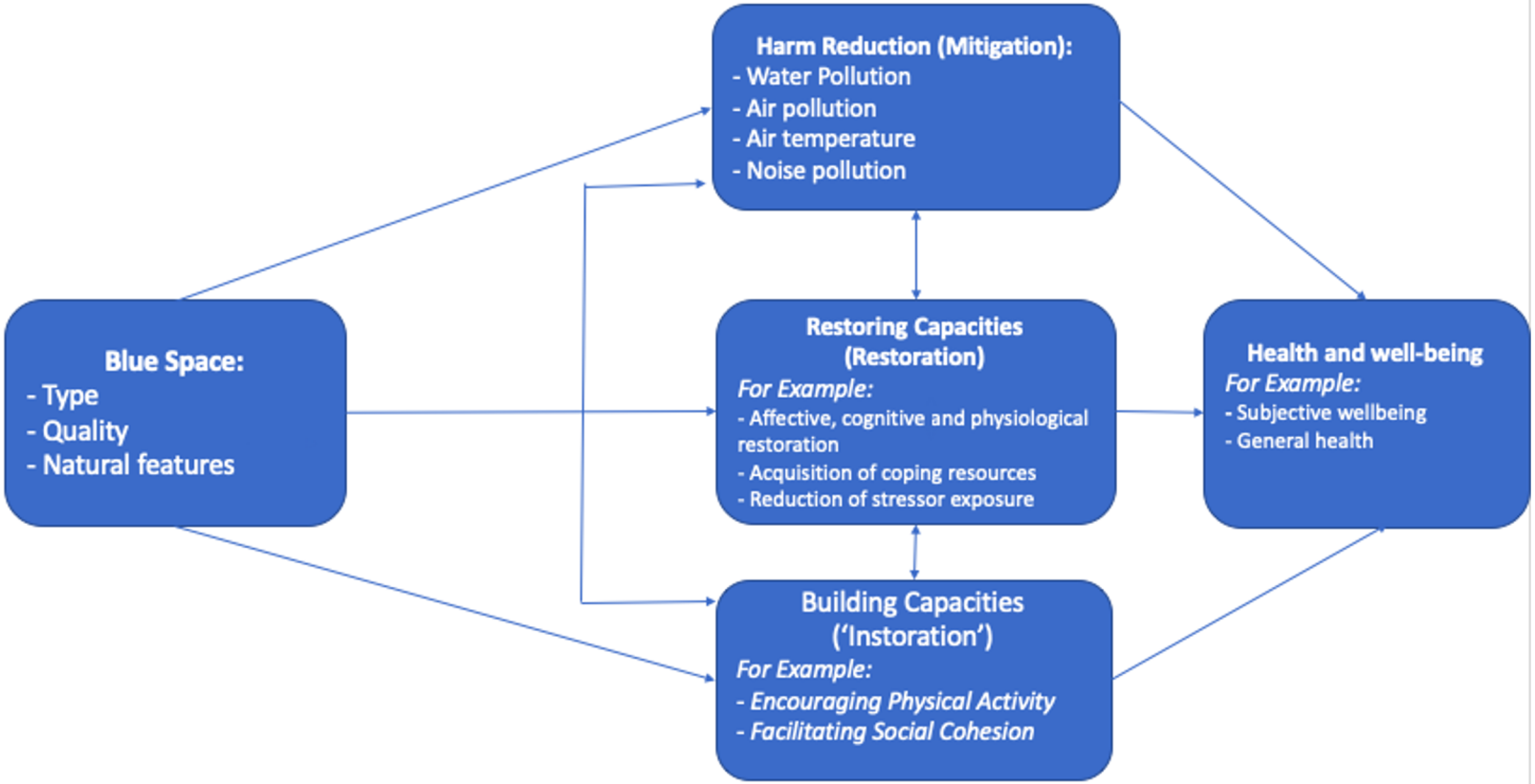


Figure 3. The odds ratios (OR) and 95% confidence intervals of reporting good health and high well-being as a function of nature visits and selected covariates (controlling for all other covariates).

NBS threefold pathway to health & well-being

Bonaiuto & Albers, 2020 (adapted Markevych et al., 2017)



Mitigation pathway: NBS reducing harm

Buffering environmental stressors (pollution, temperature)

Gehrels et al (2016)

For example, a view of the sea, and other natural environments, was associated with reduced annoyance from road noise in Hong Kong (Leung et al., 2017):

NBS views decreases the probability value of invoking a high noise annoyance response.

Mitigation pathway: NBS reducing harm

Buffering environmental stressors (pollution, temperature)
e.g., Leung et al. (2017), HK *n* = 2,033 adults

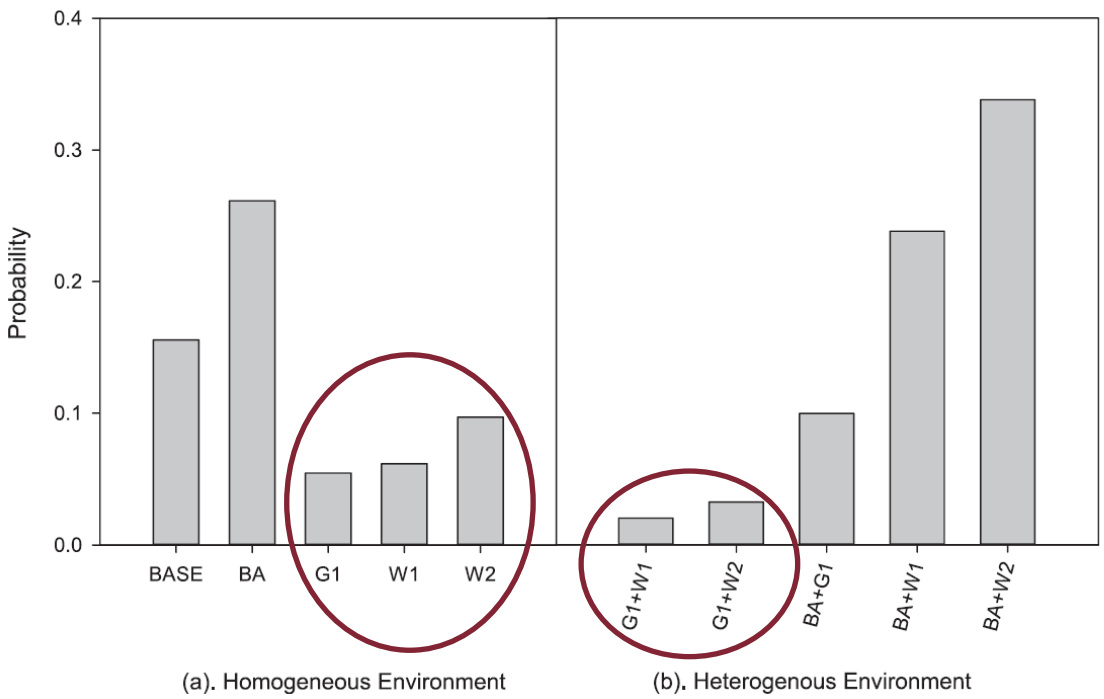


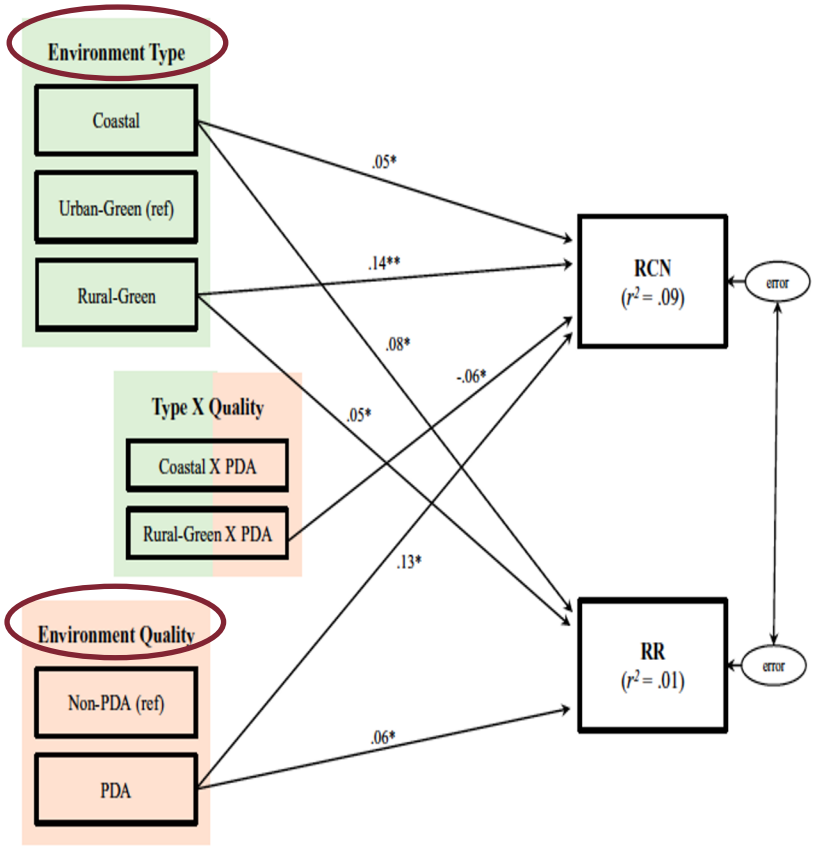
FIG. 2. The probability values induced by the perceptions of different types of neighborhood views - BASE: Baseline condition; BA: Views of noise barrier; G1: Views of greenery; W1: Views of sea; W2: Views of urban river.

NBS views decreases the probability value of invoking a high noise annoyance response.

Restoration pathway: NBS restoring capacities

Recovering emotion regulation and/or cognitive capacity

Wyles et al. (2019) UK *n*=4,515 nature visitors representative



	Coastal			Rural-Green			PDA			Coastal x PDA			Rural-Green x PDA		
	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect
RCN	.05*	.05*	-	.14**	.14**	-	.13*	.13*	-	-	-	-	-.06*	-.06*	-
RR	.08*	.08*	-	.05*	.05*	-	.06*	.06*	-	-	-	-	-	-	-

Recalled Connectedness to Nature (RCN)
"I felt close to nature."

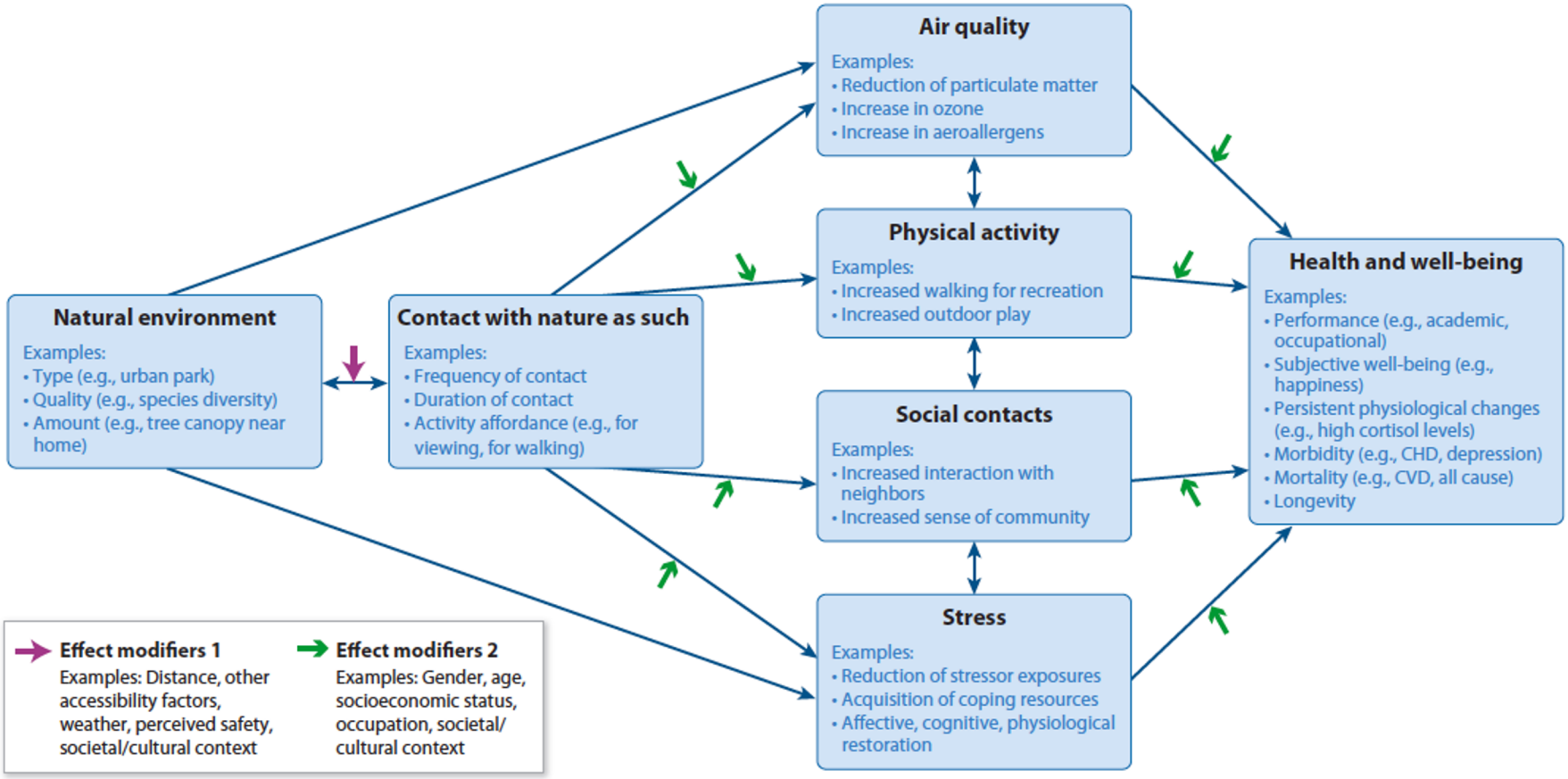
Recalled Restoration (RR)
"calm/relaxed" and "refreshed/revitalized"

Figure 4. The SEM model highlighting significant predictors of both recalled connectedness to nature (RCN) and recalled restoration (RR).
Note. This model shows direct standardized effects while controlling for the previously found significant covariates (namely, gender, age, duration, activity, and companion). There was a good model fit, $\chi^2(df = 8) = 4.12$, $p = .85$; RMSEA = .000, CFI = 1.00. PDA = protected or designated area; ref = reference category.

‘Instoration pathway’: NBS building capacities

Promotion of physical activities and social cohesion, for future buffering and resilience

Hartig et al. (2014): *the ‘instoration effect’ happens through Physical Activities and Social Contacts, which are intertwined*



‘Instoration pathway’: NBS building capacities

Promotion of physical activities and social cohesion, for future buffering and resilience

Pasanen et al. (2019), UK *n* = 21,097 adults (2008 and 2012)

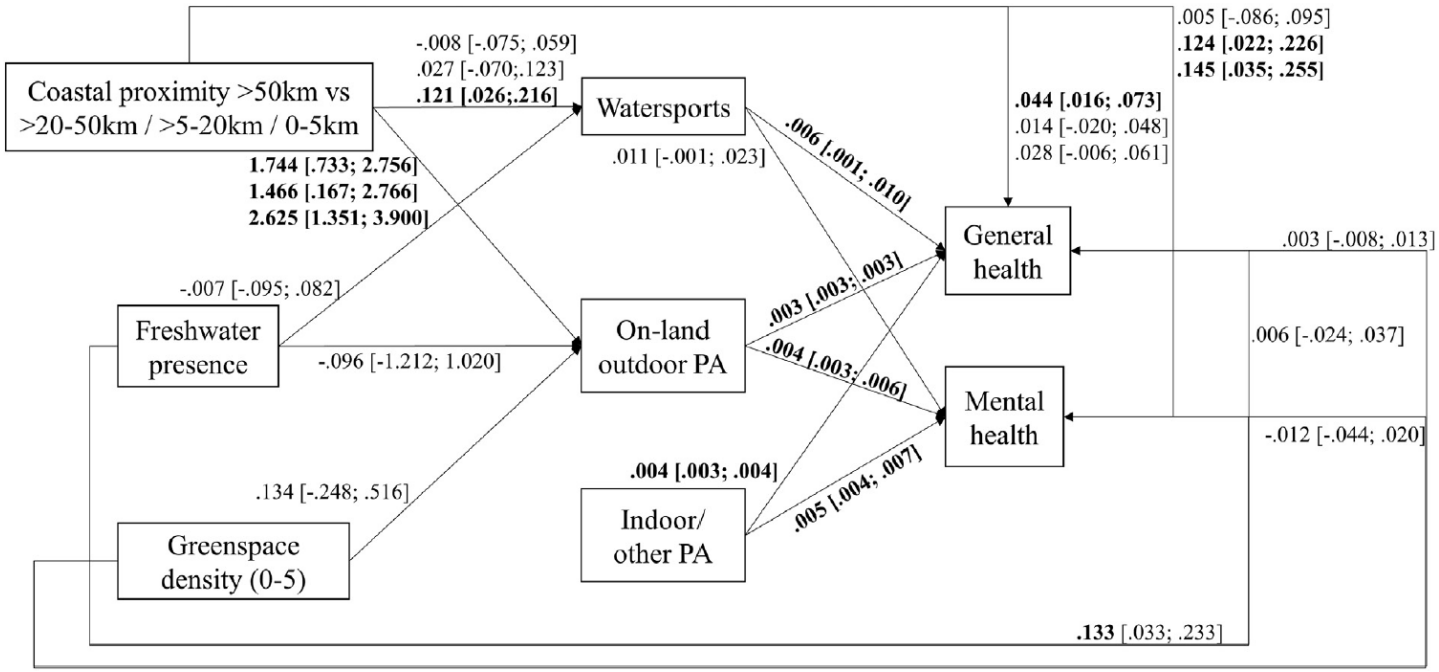


Fig. 2. Unstandardised estimates and their 95% CIs in the path model (n = 21,097), adjusted for all covariates (provided in Supplementary Table B.1). All PA variables are measured in MET h/week. Error covariances between the mediators and the outcomes are not shown for readability but they are provided in Supplementary Table B.1. Bold typeface indicates statistical significance.

‘Instoration pathway’: NBS building capacities

Promotion of pro-environmental attitudes and behaviours

De Dominicis et al. (2017)

APPLIED ENVIRONMENTAL EDUCATION & COMMUNICATION
https://doi.org/10.1080/1533015X.2017.1322014

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Evaluating the role of protected natural areas for environmental education in Italy

Stefano De Dominicis[a,b,c], Marino Bonaiuto[a,c], Giuseppe Carrus[c,d], Paola Passafaro[a,c], Paola Perucchini[c,d], and Mirilia Bonnes[a,c]

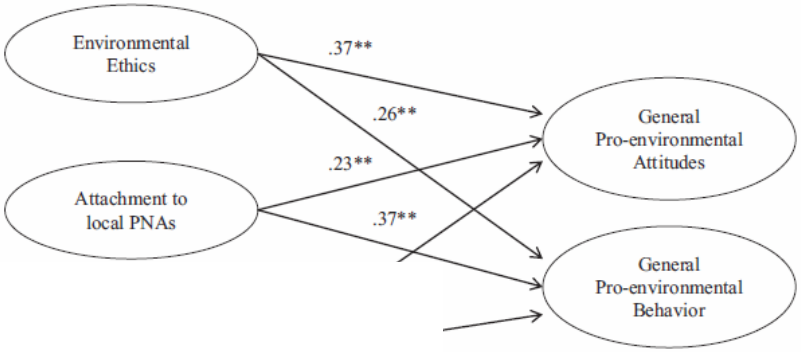

Figure 1. Conceptual model synthetizing common factors significantly influencing children’s general proenvironmental attitudes and behaviors in the posttest of Study 2. *Note.* PNA = Protected Natural Areas.

‘Instoration pathway’: NBS building capacities

Promotion of pro-environmental attitudes and behaviours

De Dominicis et al. (2017)

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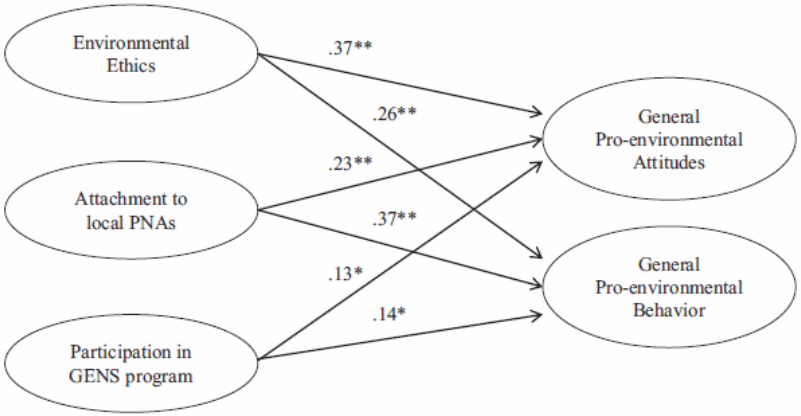

Figure 1. Conceptual model synthetizing common factors significantly influencing children’s general proenvironmental attitudes and behaviors in the posttest of Study 2. *Note.* PNA = Protected Natural Areas.

‘Instoration pathway’: NBS building capacities

Promotion of pro-biodiversity behaviours and consumption

Molinario et al. (in press)

Life development

- Norms (both Family and School) about Nature
- Early experiences (both ordinary and extraordinary) in Nature

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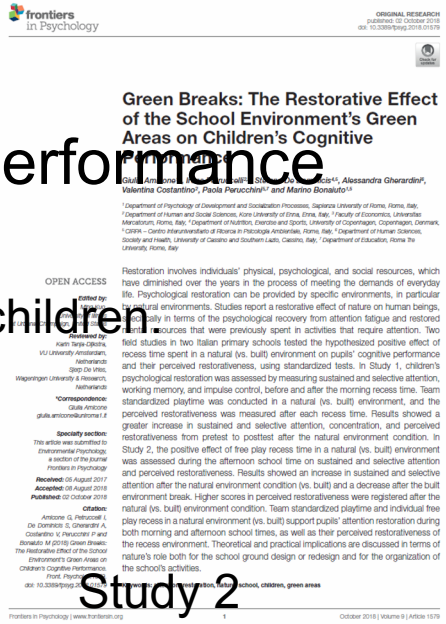
- Values (Biospheric) and Environmental Identity (+ Knowledge)

- Adult actions to protect nature and biodiversity
- Food biodiversity sustainable consumption habits

Ex. 1: NBS short-term effects

A school green break improves cognitive performance


frontiers in Psychology

ORIGINAL RESEARCH
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Green Breaks: The Restorative Effect of the School Environment's Green Areas on Children's Cognitive Performance

Valentina Costantino[3], Paola Perucchini[2] and Marino Bonaiuto[1,4]

[1] Department of Psychology of Development and Socialization Processes, Sapienza University of Rome, Rome, Italy, [2] Department of Human and Social Sciences, Kore University of Enna, Enna, Italy, [3] Faculty of Economics, Universitas Mercatorum, Rome, Italy, [4] Department of Nutrition, Exercise and Sports, University of Copenhagen, Copenhagen, Denmark, [5] CIRPA – Centro Interuniversitario di Ricerca in Psicologia Ambientale, Rome, Italy, [6] Department of Human Sciences, Society and Health, University of Cassino and Southern Lazio, Cassino, Italy, [7] Department of Education, Roma Tre University, Rome, Italy

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Netherlands

*Correspondence:
Giulia Amicone
giulia.amicone@uniroma1.it

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Restoration involves individuals' physical, psychological, and social resources, which have diminished over the years in the process of meeting the demands of everyday life. Psychological restoration can be provided by specific environments, in particular natural environments. Studies report a restorative effect of nature on human beings, especially in terms of the psychological recovery from attention fatigue and restored mental resources that were previously spent in activities that require attention. Two field studies in two Italian primary schools tested the hypothesized positive effect of recess time spent in a natural (vs. built) environment on pupils' cognitive performance and their perceived restorativeness, using standardized tests. In Study 1, children's psychological restoration was assessed by measuring sustained and selective attention, working memory, and impulse control, before and after the morning recess time. Team standardized playtime was conducted in a natural (vs. built) environment, and the perceived restorativeness was measured after each recess time. Results showed a greater increase in sustained and selective attention, concentration, and perceived restorativeness from pretest to posttest after the natural environment condition. In Study 2, the positive effect of free play recess time in a natural (vs. built) environment was assessed during the afternoon school time on sustained and selective attention and perceived restorativeness. Results showed an increase in sustained and selective attention after the natural environment condition (vs. built) and a decrease after the built environment break. Higher scores in perceived restorativeness were registered after the natural (vs. built) environment condition. Team standardized playtime and individual free play recess in a natural environment (vs. built) support pupils' attention restoration during both morning and afternoon school times, as well as their perceived restorativeness of the recess environment. Theoretical and practical implications are discussed in terms of nature's role both for the school ground design or redesign and for the organization of the school's activities.

Keywords: restoration, [illegible] school, children, green areas

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To test the restorative effects of spending recess time on different components of attention on Primary school children

Two different school environments (Rome, Italy):

Study 1 Study 2

- **Green area (school garden)**

FIGURE 1 | Natural environment of Study 1.

FIGURE 6 | Natural environment for Study 2.

- **Built area (school playground)**

FIGURE 2 | Built environment of Study 1.

FIGURE 7 | Built environment for Study 2.

Amicone et al. (2018)

Study 1: Attention test performance and PRS

TABLE 1 | Marginal means, standard deviations and 't' of sustained and selective attention, working memory, and impulse control scores in Study 1.

	Sustained and selective attention			Working memory			Impulses' control		
	T1	T2		T1	T2		T1	T2	
Condition	***M* (*SD*; *N*)**	***M* (*SD*; *N*)**	***t*; sig.**	***M* (*SD*; *N*)**	***M* (*SD*; *N*)**	***t*; sig.**	***M* (*SD*; *N*)**	***M* (*SD*; *N*)**	***t*; sig.**
Natural environment	31.85 (2.74; 75)	32.61 (2.70; 75)	$t = 2.45$; $p = 0.016$	15.22 (3.02; 73)	16.38 (3.31; 73)	$t = 4.12$; $p < 0.001$	16.85 (3.77; 75)	16.79 (3.66; 75)	$t = 0.19$; $p = 0.85$
Built environment	31.55 (3.59; 75)	31.77 (3.45; 75)	$t = 0.73$; $p = 0.47$	15.42 (3.94; 73)	15.86 (3.27; 73)	$t = 1.55$; $p = 0.12$	16.59 (3.46; 75)	16.97 (2.72; 75)	$t = 1.04$; $p = 0.30$

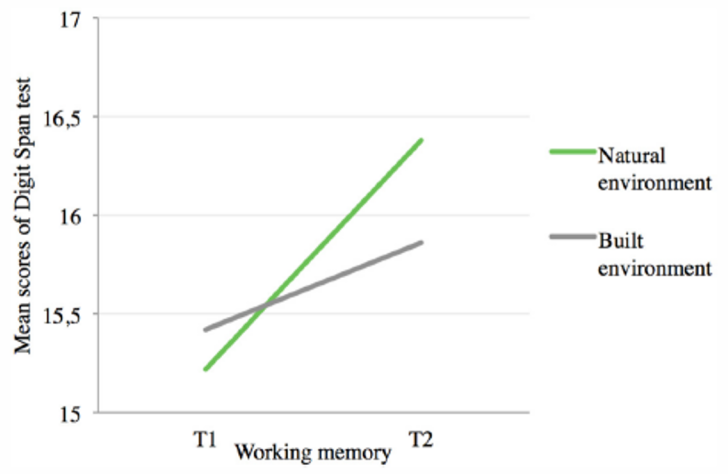


FIGURE 4 | Results of Study 1 for H2. Repeated measures ANCOVA for the three-way interaction effect of condition and time on working memory, controlling for the presentation order [$F(1,71) = 43.04$; $p < 0.001$; $\eta_p^2 = 0.38$]. Natural environment condition T1 ($M = 15.22$, $SE = 0.34$); natural environment condition T2 ($M = 16.38$, $SE = 0.38$), $t(73) = 4.12$; $p < 0.001$; $d = 0.68$. Built environment condition T1 ($M = 15.42$, $SE = 0.41$); built environment condition T2 ($M = 15.86$, $SE = 0.38$) in their sustained and selective attention scores, $t(73) = 1.55$; $p = 0.12$; $d = 0.26$.

TABLE 2 | Marginal means and standard deviations of perceived restorativeness in Study 1.

Condition	***M* (*SD*; *N*)**
Natural environment	5.64 (1.59; 76)
Built environment	4.14 (2.06; 76)

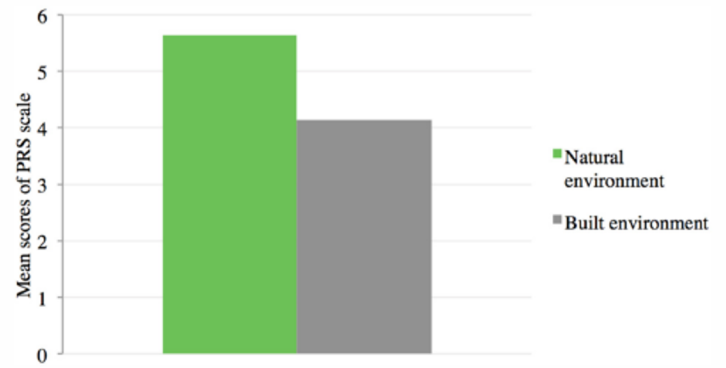


FIGURE 5 | Results of Study 1 for H4. Repeated measures ANCOVA for the effect of condition on perceived restorativeness, controlling for manipulation order, $F(1,74) = 30.53$: $p = 0.000$; $\eta_p^2 = 0.292$. Natural environment condition ($M = 5.64$, $SD = 1.59$, $N = 76$); built environment condition ($M = 4.14$, $SD = 2.06$, $N = 76$).

Study 2: Attention test performance and PRS

TABLE 3 | Standardized means and standard deviations and *z*-values of sustained and selective attention scores in Study 2.

	Sustained and selective attention		
	Natural environment	Built environment	
	M (SD; N)	M (SD; N)	z; sig.
T1	–0.08 (1.21; 18)	0.102 (0.78; 17)	$z = 0.54$; $p = 0.59$
T2	0.37 (1.10; 18)	–0.40 (0.72; 17)	$z = 2.47$; $p = 0.007$

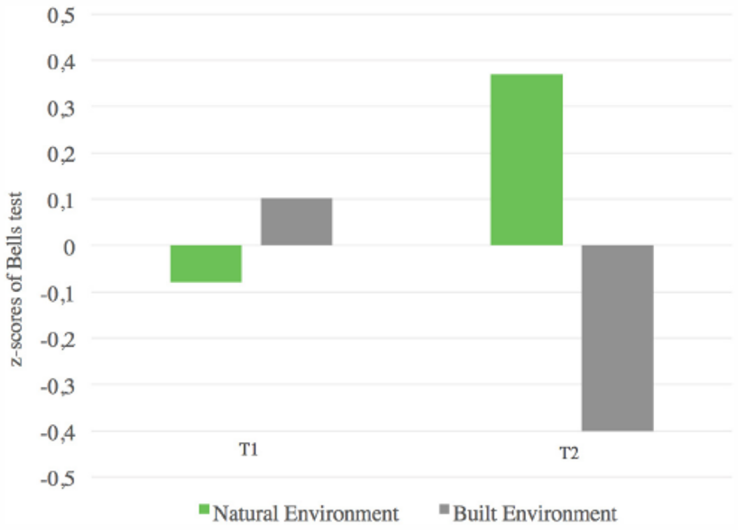


FIGURE 9 | Results of Study 2 for H5. *z*-test for sustained and selective attention scores at T1; natural environment condition ($M = -0.08$; $SD = 1.21$; $N = 18$) and built environment condition ($M = 0.102$; $SD = 0.78$; $N = 17$): $z(33) = 0.54$; $p = 0.59$; *z*-test for sustained and selective attention scores at T2; natural environment condition ($M = 0.37$; $SD = 1.10$; $N = 18$) and built environment condition ($M = -0.40$; $SD = 0.72$; $N = 17$), $z(33) = 2.47$; $p = 0.007$.

TABLE 4 | Means and standard deviations of perceived restorativeness in Study 2.

	Perceived restorativeness
	M (SD; N)
Natural environment	5.33 (2.63; 18)
Built environment	2.85 (1.71; 17)

Ex. 1: NBS short-term on child self-regulation

e.g., Weeland et al. (2019), *JEvP*

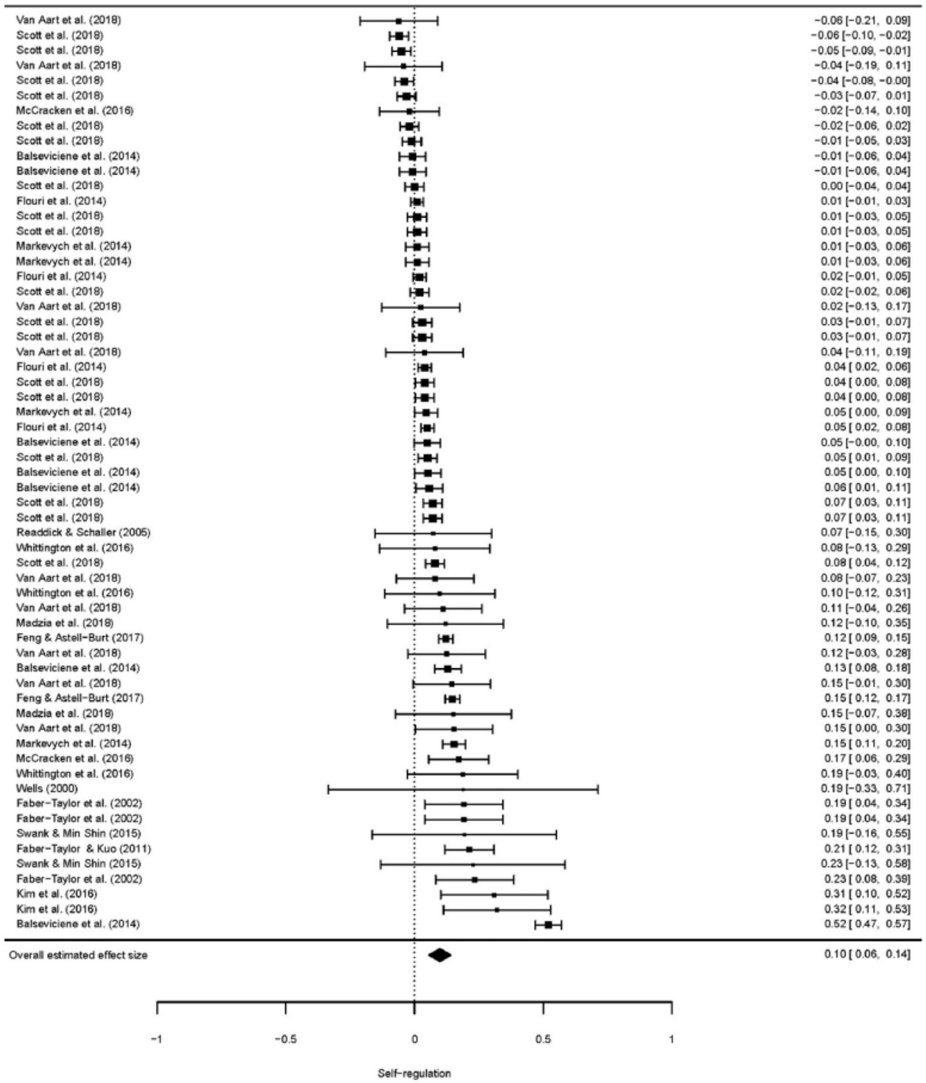


Fig. 2. Forest Plot Effect sizes Correlational Studies, including 95% confidence interval effect size.
Note. Forest plots were originally developed to show one effect size per study. Some studies are therefore mentioned more than once, to show multiple effect sizes from the same study.

J. Weeland, et al. Journal of Environmental Psychology 65 (2019) 101326

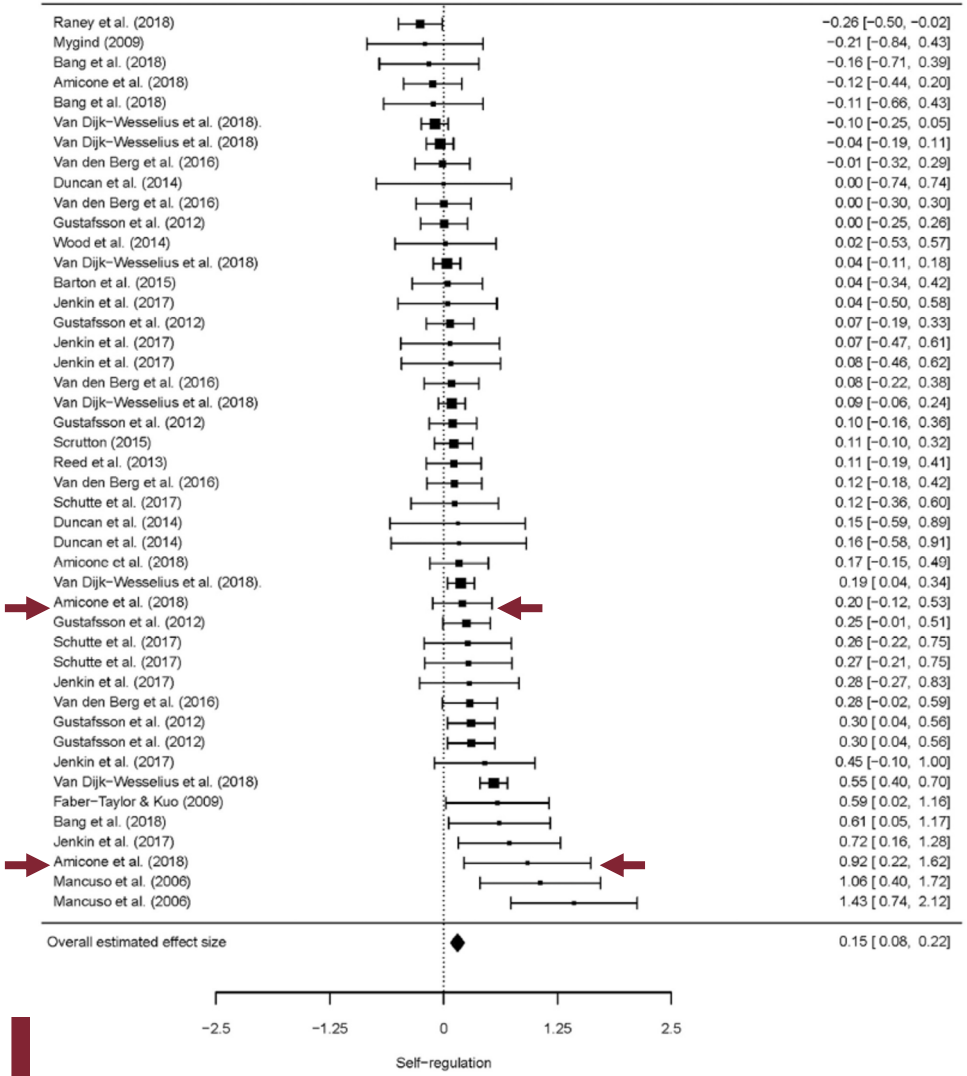


Fig. 3. Forest Plot Effect sizes Experimental Studies, including 95% confidence interval effect size.
Note. Forest plots were originally developed to show one effect size per study. Some studies are therefore mentioned more than once, to show multiple effect sizes from the same study.

Ex. 2: NBS long-term effects (1 Mln, 0-10 yrs)

Childhood green areas buffer adult mental disorders (2019)

PNAS

Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood

Kristine Engemann[a,b,c,1], Carsten Bøcker Pedersen[c,d,e], Lars Arge[f], Constantinos Tsirogiannis[f], Preben Bo Mortensen[c,d,e], and Jens-Christian Svenning[a,b]

[a]Section for Ecoinformatics & Biodiversity, Department of Bioscience, Aarhus University, 8000 Aarhus C, Denmark; [b]Center for Biodiversity Dynamics in a Changing World, Department of Bioscience, Aarhus University, 8000 Aarhus C, Denmark; [c]Centre for Integrated Register-based Research, Aarhus University, 8210 Aarhus V, Denmark; [d]National Centre for Register-based Research, School of Business and Social Sciences, Department of Economics and Business Economics, Aarhus University, 8210 Aarhus V, Denmark; [e]The Lundbeck Foundation Initiative for Integrative Psychiatric Research, Aarhus University, 8210 Aarhus V, Denmark; and [f]Center for Massive Data Algorithmics, Department of Computer Science, Aarhus University, 8200 Aarhus N, Denmark

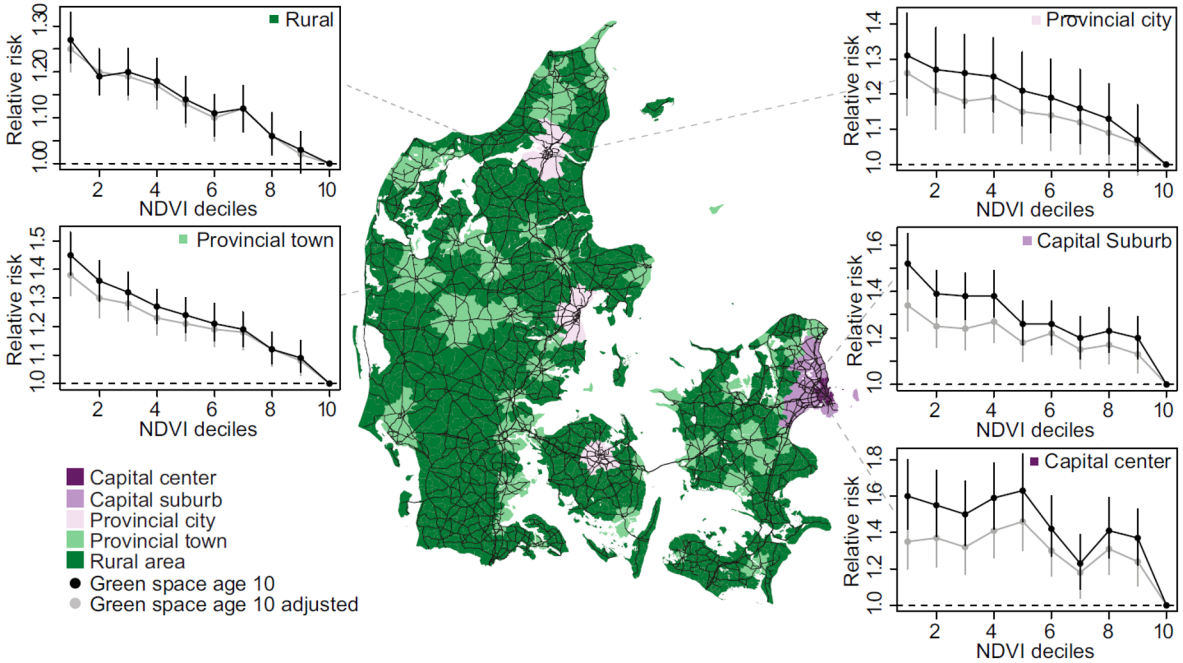


Fig. 2. The association between relative risk of developing any psychiatric disorder and childhood green space presence across urbanization levels. Data were split between each of the five urbanization classes (Capital center n = 56 650, Capital suburb n = 124,193, Provincial city n = 90,648, Provincial town n = 265,570, and Rural n = 376,525). NDVI was recalculated as deciles, and separate models, shown in black, were fitted within each urbanization class to determine the shape of the association between green space and mental health. Integer values on the x axis refer to decile ranges, i.e., 1 corresponds to decile 0 to 10%. An additional model, shown in grey, was fitted for each urbanization class to adjust for urbanization and parents' socioeconomic status. Estimates of relative risk from all five models were adjusted for year of birth and gender and plotted with 95% CIs within each degree of urbanization.

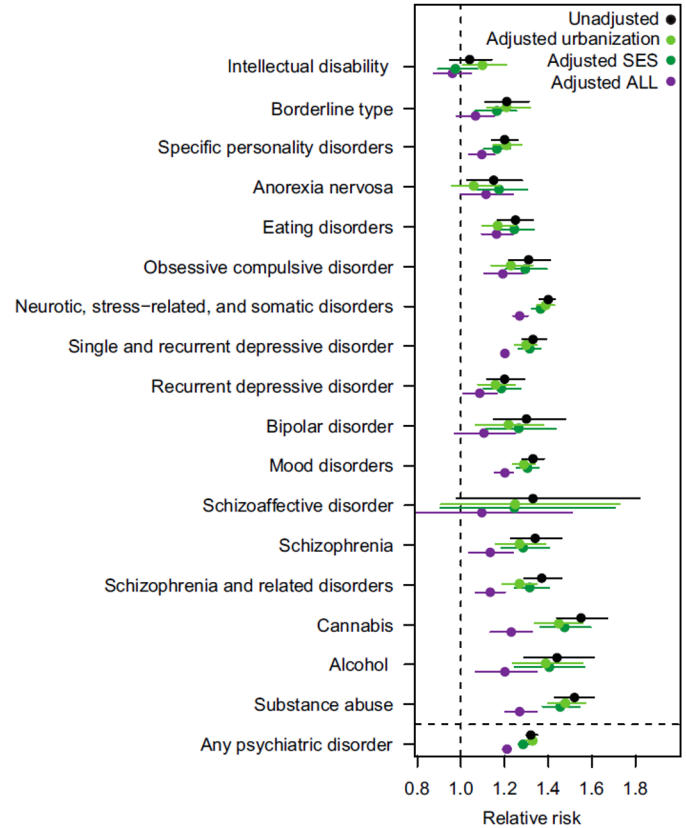
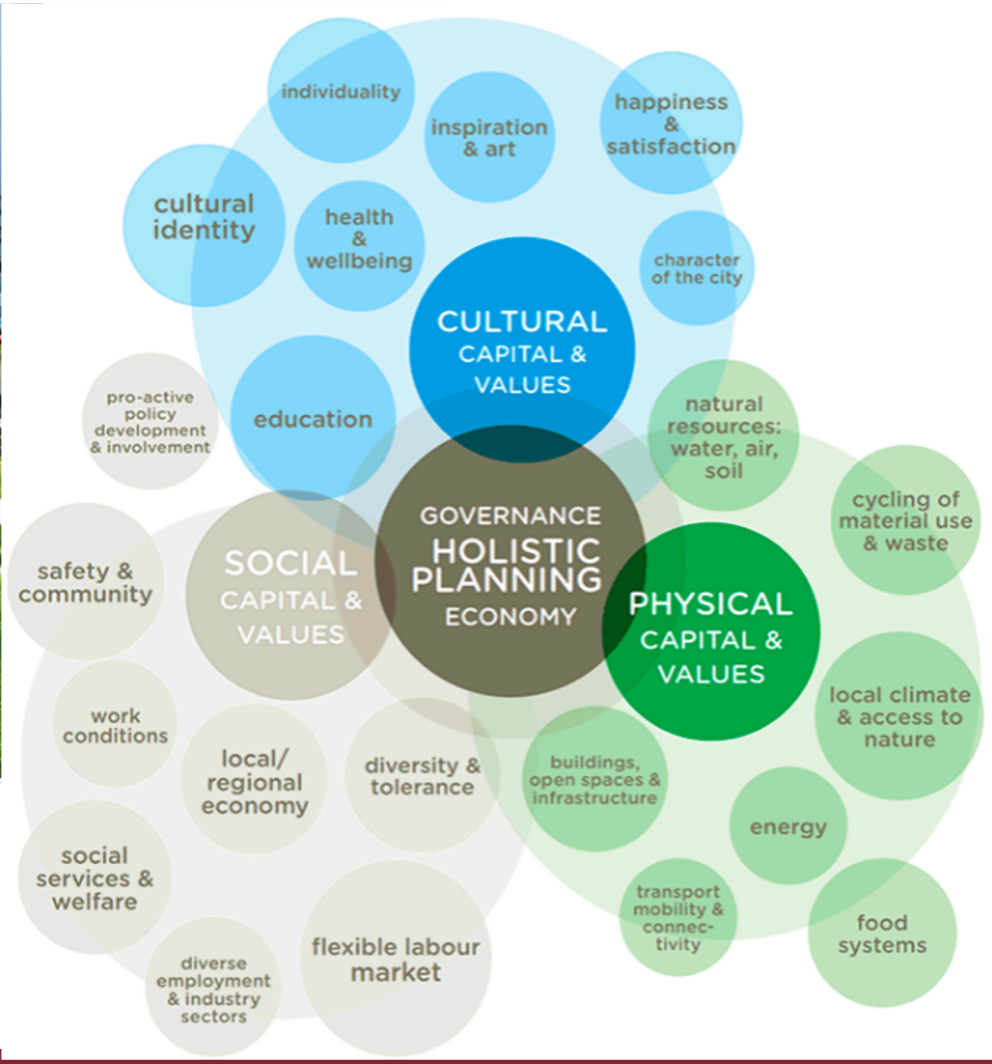


Fig. 1. The association between childhood green space presence and the relative risk of developing a psychiatric disorder later in life. Green space presence was measured as the mean NDVI within a 210 × 210 m square around place of residence (n = 943,027). Low values of NDVI indicate sparse vegetation, and high values indicate dense vegetation. Relative risk estimates are relative to the reference level (set to the highest decile) for NDVI fitted as numeric deciles in classes of 10. Estimates above the dashed line indicate higher risk of developing a given psychiatric disorder for children living at the lowest compared with the highest values of NDVI. Three additional models were fitted to adjust for the effect of urbanization, parental socioeconomic status (SES), and the combined effect of urbanization, parental and municipal socioeconomic factors, parental history of mental illness, and parental age at birth on risk estimates. All estimates were adjusted for age, year of birth, and gender and plotted with 95% CIs.

Evidence Based Design, Management, Policy

Implications for urban design, management, decisions

images from Ramboll.com



EBD implications example and NBS diffusion

Bosco verticale, Porta Nuova neighbourhood in Milan (by Boeri Studio, 2009-2014)

Hotel, Wanfeng valley, Guizhou province, China

W350, Tokyo, Japan

Municipality Chavannes-Près-Renens, CH

Municipality Villiers sur Marne, Paris area FR

Jaarbeursboulevar area, Utrecht station, NL

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