

University of Exeter

Natural environments and physical activity: Epidemiology, experimentation, infrastructure, and intervention

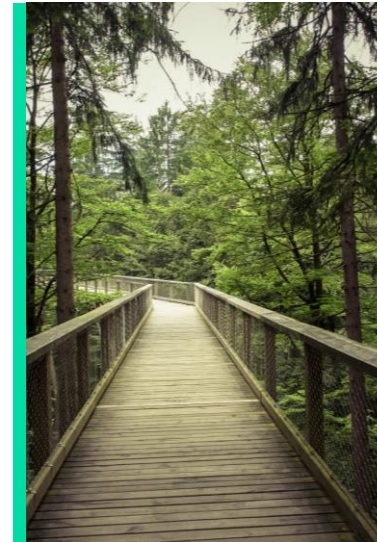
Lewis Elliott (L.R.Elliott@exeter.ac.uk)
FUSE Physical Activity Workshop 2023



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Overview

- Cross-sectional evidence of nature—physical activity associations
- Green exercise
- Greenspace creation/improvement interventions and greenspace promotion interventions
- Economic evaluations



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Definitions

- Greenspace / nature / natural environment
 - I will use these interchangeably!
- Typically, the research herein refers to managed biotic greenspace (parks), and abiotic aquatic environments (beaches / coast / rivers)
- I will refer both to *indirect* exposure (access/availability of greenspace) and *intentional* exposure (leisure visits)



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Cross-sectional evidence



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Cross-sectional evidence

- Coombes et al., (2010)
- Participants: 6,821 adults from Bristol
- Exposure: Distance to different types of greenspace at least 2ha in size
- Outcomes: visiting greenspace at least once per week, self-reporting PA guidelines (≥ 5 days of MVPA a week)



Coombes, E., Jones, A. P., & Hillsdon, M. (2010). The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social Science & Medicine*, 70(6), 816–822. <https://doi.org/10.1016/j.socscimed.2009.11.020>

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Cross-sectional evidence

Distance measure	Visiting green space at least once a week		Achieving physical activity guidelines*	
	OR	95% CI	OR	95% CI
All green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 100 m)	0.97	(0.74–1.01)	0.95	(0.82–1.01)
Quantile 2	0.79	(0.68–0.92)	1.01	(0.87–1.17)
Quantile 4 (furthest > 500 m)	0.64**	(0.55–0.75)	0.95**	(0.81–1.10)
Formal green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 800 m)	0.73	(0.63–0.85)	0.87	(0.76–1.01)
Quantile 2	0.73	(0.63–0.85)	0.77	(0.62–0.84)
Quantile 4 (furthest > 2250 m)	0.64**	(0.55–0.75)	0.95**	(0.83–0.88)
Informal green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 200 m)	0.80	(0.69–0.93)	0.96	(0.82–1.11)
Quantile 2	0.70	(0.60–0.82)	0.97	(0.83–1.12)
Quantile 4 (furthest > 680 m)	0.60**	(0.68–0.95)	0.98**	(0.84–1.15)
Natural green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 250 m)	1.03	(0.88–1.20)	1.04	(0.89–1.20)
Quantile 2	0.85	(0.73–0.99)	1.04	(0.89–1.20)
Quantile 4 (furthest > 800 m)	0.80**	(0.68–0.94)	1.05**	(0.91–1.22)
Young People's green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 100 m)	1.07	(0.92–1.30)	1.06	(0.92–1.23)
Quantile 2	0.98	(0.84–1.14)	0.91	(0.79–1.06)
Quantile 4 (furthest > 2800 m)	0.95**	(0.81–1.11)	0.91**	(0.78–1.06)
Sports green spaces	1.00	–	1.00	–
Quantile 1 (nearest < 640 m)	0.94	(0.81–1.10)	1.09	(0.94–1.26)
Quantile 2	0.89	(0.77–1.04)	1.05	(0.91–1.22)
Quantile 4 (furthest > 1470 m)	0.87*	(0.74–1.02)	1.10**	(0.95–1.28)

Coombes, E., Jones, A. P., & Hillsdon, M. (2010). The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social Science & Medicine*, 70(6), 816–822. <https://doi.org/10.1016/j.socscimed.2009.11.020>

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Cross-sectional evidence

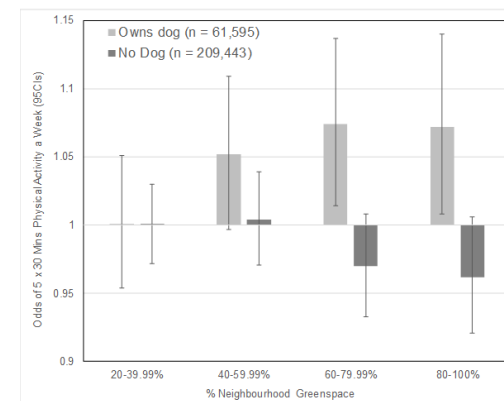
- White et al., (2018)
- Participants: 280,790 participants from MENE
- Exposure: LSOA-level greenspace (exc. gardens)
- Outcome: ≥ 5 days of 30 minutes of moderate-to-vigorous physical activity through leisure or transport
- Moderators: Dog ownership (yes/no)



White, M. P., Elliott, L. R., Wheeler, B. W., & Fleming, L. E. (2018). Neighbourhood greenspace is related to physical activity in England, but only for dog owners. *Landscape and Urban Planning*, 174, 18-23. <https://doi.org/10.1016/j.landurbplan.2018.01.004>

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Cross-sectional evidence



White, M. P., Elliott, L. R., Wheeler, B. W., & Fleming, L. E. (2018). Neighbourhood greenspace is related to physical activity in England, but only for dog owners. *Landscape and Urban Planning*, 174, 18-23. <https://doi.org/10.1016/j.landurbplan.2018.01.004>

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Cross-sectional evidence

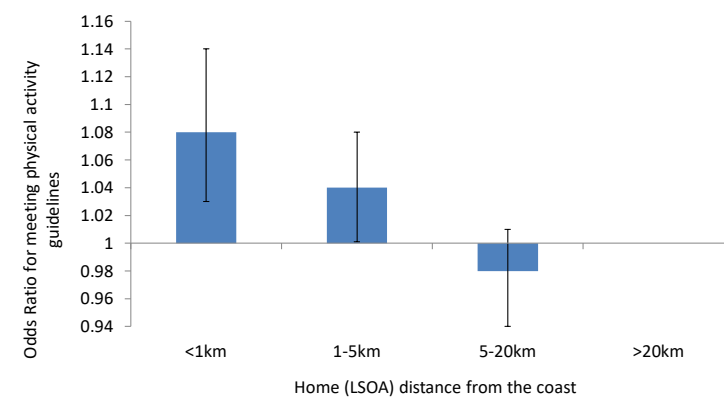
- White et al., (2014)
- Participants: 183,755 participants in MENE
- Exposure: Residential proximity to the coastline
- Outcomes: Self-reported achieving physical activity guidelines (≥ 5 days of MVPA in leisure time or transport in last week)



White, M. P., Wheeler, B. W., Herbert, S., Alcock, I., & Depledge, M. H. (2014). Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? *Preventive Medicine*, 69, 135-140. <https://doi.org/10.1016/j.ypmed.2014.09.016>

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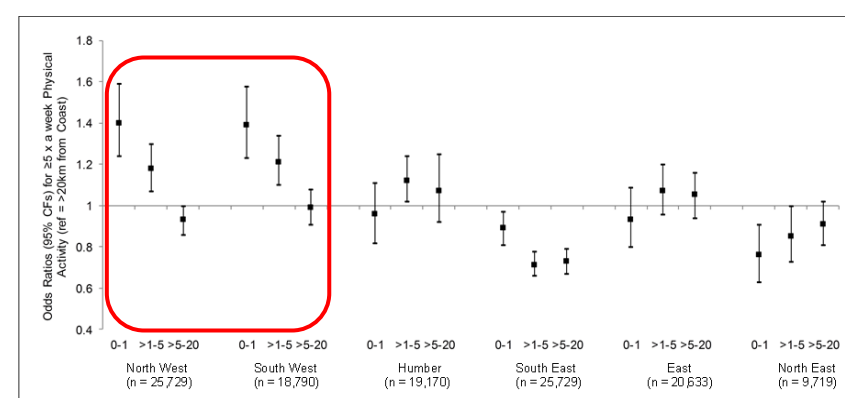
Cross-sectional evidence



White, M. P., Wheeler, B. W., Herbert, S., Alcock, I., & Depledge, M. H. (2014). Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? *Preventive Medicine*, 69, 135-140. <https://doi.org/10.1016/j.ypmed.2014.09.016>

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Cross-sectional evidence

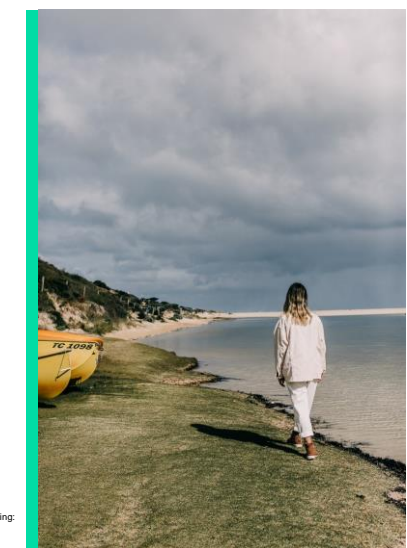


White, M. P., Wheeler, B. W., Herbert, S., Alcock, I., & Depledge, M. H. (2014). Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? *Preventive Medicine*, 69, 135-140. <https://doi.org/10.1016/j.ypmed.2014.09.016>

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Cross-sectional evidence

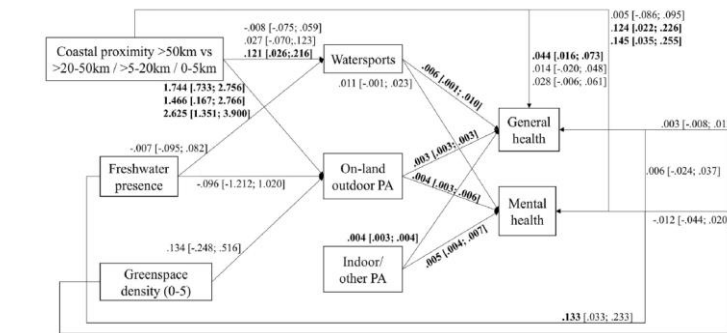
- Pasanen et al., (2019)
- Participants: 21,097 adults from the Health Survey for England
- Exposures: Residential proximity to the coastline (among others)
- Outcomes: General health (5-point scale) and mental health (GHQ-12)
- Mediators: MET-hours per week engaged in at least moderate-intensity watersports, on-land physical activity, and indoor physical activity



Pasanen, T. P., White, M. P., Wheeler, B. W., Garnett, J. K., & Elliott, L. R. (2019). Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environment International*, 131, 105016. <https://doi.org/10.1016/j.envint.2019.105016>

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Cross-sectional evidence



Pasanen, T. P., White, M. P., Wheeler, B. W., Garrett, J. K., & Elliott, L. R. (2019). Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environment International*, 131, 105016. <https://doi.org/10.1016/j.envint.2019.105016>

Cross-sectional evidence

•Pasanen et al., (2019)

- Greater volumes of **on-land physical activity** explained the positive relationship between closer residential proximity to the coastline and both general and mental health.
- This held when we restricted the analysis to **only "walking" activity**.
- No other significant indirect effects.



Pasanen, T. P., White, M. P., Wheeler, B. W., Garrett, J. K., & Elliott, L. R. (2019). Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environment International*, 131, 105016. <https://doi.org/10.1016/j.envint.2019.105016>

Cross-sectional evidence

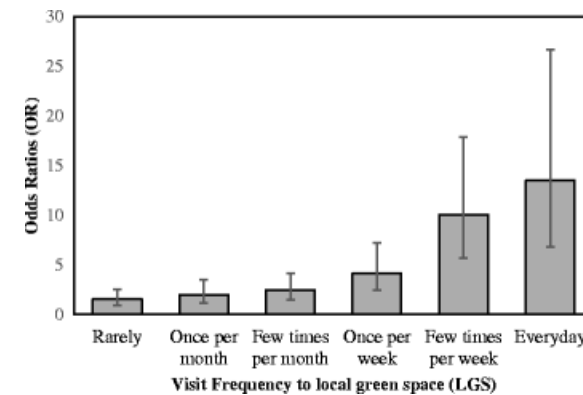
•Flowers et al., (2016)

- Participants: 2,079 British adults
- Exposure: Self-reported **frequency of visits** to greenspace
- Outcomes: Whether the participant self-reported achieving 600 MET minutes of physical activity per week



Flowers, E. P., Freeman, P., & Gladwell, V. F. (2016). A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels. *BMC Public Health*, 16(1). <https://doi.org/10.1186/s12889-016-3050-9>

Cross-sectional evidence



Flowers, E. P., Freeman, P., & Gladwell, V. F. (2016). A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels. *BMC Public Health*, 16(1). <https://doi.org/10.1186/s12889-016-3050-9>

Cross-sectional evidence

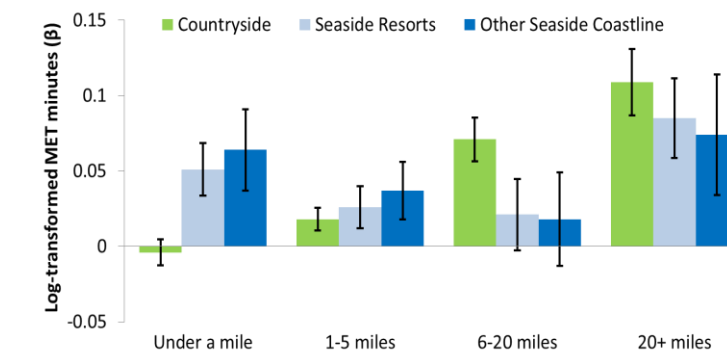
•Elliott et al., (2015)

- Participants: 71,603 adults from MENE.
- Exposure: Type of natural environment visited.
- Outcome: Volume of physical activity achieved on visit (MET minutes)



Elliott, L. R., White, M. P., Taylor, A. H., & Herbert, S. (2015). Energy expenditure on recreational visits to different natural environments. *Social Science & Medicine*, 130, 53-60. <https://doi.org/10.1016/j.socscimed.2015.06.038>

Cross-sectional evidence



Elliott, L. R., White, M. P., Taylor, A. H., & Herbert, S. (2015). Energy expenditure on recreational visits to different natural environments. *Social Science & Medicine*, 130, 53-60. <https://doi.org/10.1016/j.socscimed.2015.06.038>

Cross-sectional evidence summary

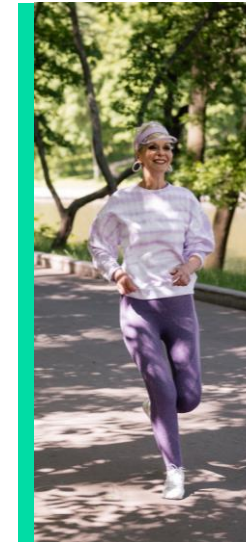
- Closer proximity to greenspace is associated with physical activity attainment.
 - ...but this is limited to certain types of greenspace
- Greater availability of greenspace is associated with physical activity attainment.
 - ...but only if you own a dog
- Closer proximity to the coast is associated with physical activity attainment.
 - ...but only in western regions of the country.
 - ...and it might be simply the result of greater volumes of walking.
- Visits to green/bluespace associated with higher physical activity attainment and energy expenditure.
 - ...but the type of space and how far you travel are important
 - ...which leads to the elephant in the room – residual confounding.



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Green exercise

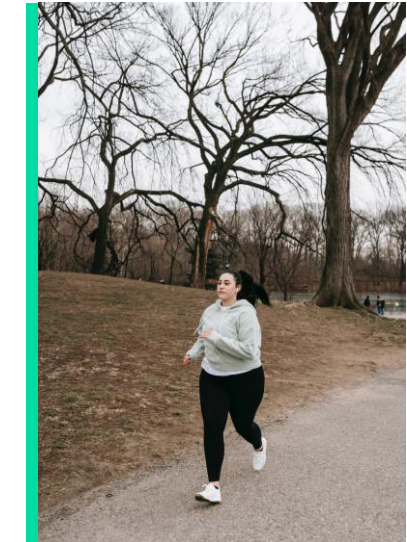


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Green exercise

- Wicks et al. (2022)
- Participants: 1,800 individuals from 24 experimental studies (review and meta-analysis)
- Exposure: Whether the physical activity took place in an urban environment or a natural environment
- Outcome: Any permitted psychological outcome

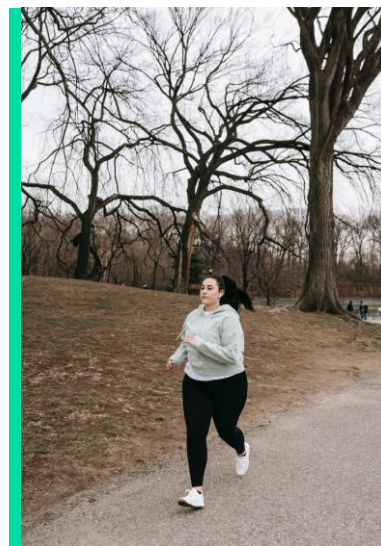
Wicks, C., Barton, J., Orbell, S., & Andrews, L. (2022). Psychological benefits of outdoor physical activity in natural versus urban environments: A systematic review and meta-analysis of experimental studies. *Applied Psychology: Health and Well-Being*, 14(1). <https://doi.org/10.1111/aphw.12353>



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Green exercise

- Wicks et al. (2022)
- Most studies:
 - Involved single bouts of PA
 - 15–60 minutes
 - Western countries
 - University students
 - Aged 19–50
 - Walking



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Green exercise



TABLE 2 Results of meta-analyses comparing psychological outcomes of outdoor physical activity in natural and urban environments

Outcome	No. of participants (studies)	Statistical method	Effect estimate [95% CI]	I ²	χ ² (df)
Anxiety	720 (7)	Std. mean difference (IV, random, 95% CI)	-6.59 [-10.04, -3.13]*	91%	66.98 (df = 6)**
Depression	697 (5)	Mean difference (IV, random, 95% CI)	-0.34 [-0.62, -0.05]*	74%	15.12 (df = 4)**
Anger/ hostility	697 (5)	Mean difference (IV, random, 95% CI)	-0.57 [-0.79, -0.35]*	30%	5.71 (df = 4)
Fatigue	697 (5)	Mean difference (IV, random, 95% CI)	-1.98 [-2.77, -1.19]*	79%	19.18 (df = 4)**
Vigour	697 (5)	Mean difference (IV, random, 95% CI)	3.28 [2.84, 3.71]*	15%	4.73 (df = 4)
Positive affect	115 (2)	Std. mean difference (continuous, random, 95% CI)	0.59 [0.21, 0.98]*	92%	12.43 (df = 1)**

Note: I² indicates the level of heterogeneity in the meta-analysis; ≥70 = considerable heterogeneity. *Statistically significant outcome in favour of the natural environment (p < .05). **Chi-squared test indicates significant heterogeneity (p ≤ .10).

Wicks, C., Barton, J., Orbell, S., & Andrews, L. (2022). Psychological benefits of outdoor physical activity in natural versus urban environments: A systematic review and meta-analysis of experimental studies. *Applied Psychology: Health and Well-Being*, 14(1). <https://doi.org/10.1111/aphw.12353>

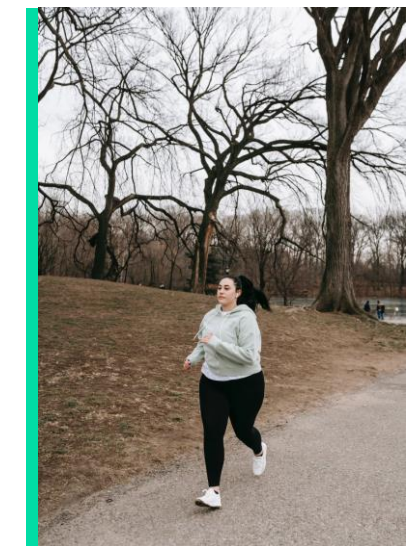
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Green exercise

- Wicks et al. (2022)
- Duration important:
 - 15 minute bouts had a stronger effect size between green and urban environments than longer bouts
 - Likely to do with the immediate environmental effects vs. the cumulative effects of the activity on mental health outcomes.
- Social context important:
 - Walks with friends, in groups, or with the researcher appeared to result in stronger differences between green and urban environments.
 - The presence of others appears to amplify the positive effect of 'green exercise'.

Wicks, C., Barton, J., Orbell, S., & Andrews, L. (2022). Psychological benefits of outdoor physical activity in natural versus urban environments: A systematic review and meta-analysis of experimental studies. *Applied Psychology: Health and Well-Being*, 14(1). <https://doi.org/10.1111/aphw.12353>

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Green exercise

•Gidlow et al., (2016)

- Participants: 38 non-stressed adults.
- Exposure: Self-paced 30 minute walks in three environments: urban, green, and blue (crossover design)
- Outcomes: Mood, cognitive function, restorative experience, salivary cortisol, and heart rate variability

Gidlow, C. J., Jones, M. V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M. P., Smith, G., & Neuwirth-Huisen, M. (2016). Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology*, 46, 22-29. <https://doi.org/10.1016/j.jenvp.2015.11.003>



Urban



Green



Blue

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Green exercise

•Gidlow et al., (2016)

- **Backwards digit span scores** significantly **better** following blue/green walks compared to urban, but **no difference** between green and blue environments.
- Mood (short POMS) improved equally in all three environments.
- Cortisol fell equally in all three environments.
- HRV measures were inconclusive.

Gidlow, C. J., Jones, M. V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M. P., Smith, G., & Neuwirth-Huisen, M. (2016). Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology*, 46, 22-29. <https://doi.org/10.1016/j.jenvp.2015.11.003>



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Green exercise evidence summary

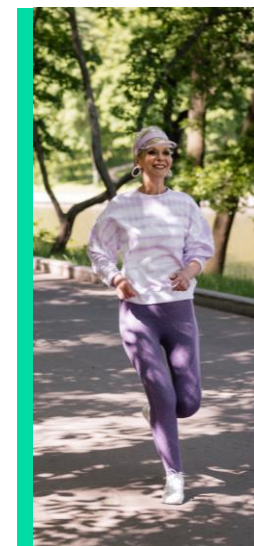
- **Consistent** evidence that being active in more natural surroundings confers positive psychological effects when compared to urban (and indoor) environments
- ...but these are typically limited to "mood" measures which are widely criticised by exercise psychologists
- ...these findings rarely extend to physiological indices (which may or may not be a problem)
- ...any effects across different types of natural environments are likely 'washed out' by the impact of physical activity on psychological indices



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Greenspace interventions



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Greenspace interventions

•Hunter et al., (2015)

- Participants: Samples from 12 studies.
- Exposure:
 - Physical change to a green space
 - Intervention to promote use of green space (e.g. awareness campaign)
 - Combination of these
 - Had to have a control group.
- Outcome: Changes in levels of physical activity (observed, self-reported etc.).

Hunter, R. F., Christian, H., Velich, J., Astell-Burt, T., Hipp, J. A., & Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine*, 124, 246-256. <https://doi.org/10.1016/j.socscimed.2014.11.051>



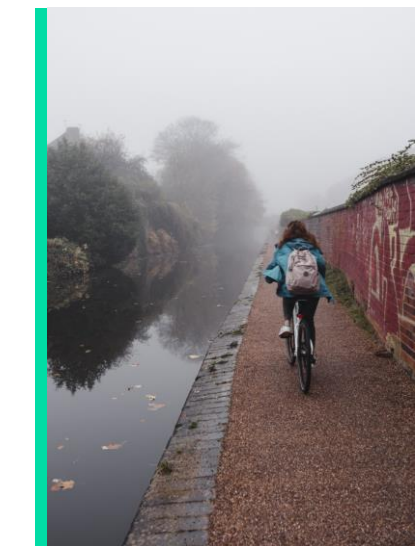
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Greenspace interventions

•Hunter et al., (2015)

- 9 studies included only physical changes to the natural environment
- 4 showed increases in PA levels, 5 did not
- Some null findings were explained e.g. by cuts in funding during the intervention.

Hunter, R. F., Christian, H., Velich, J., Astell-Burt, T., Hipp, J. A., & Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine*, 124, 246-256. <https://doi.org/10.1016/j.socscimed.2014.11.051>



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Greenspace interventions

- Hunter et al., (2015)
- 3 studies included promotional elements (1 solely, 2 mixed).
- Promotion-only intervention involved signage, promotional incentives, and outreach activities.
- Other two involved cycling trail creation and playing field renovations coupled with advertisement campaigns, launch events, and skills development amongst park staff.
- All 3 showed positive effects on PA (varied outcomes).

Hunter, R. F., Christian, H., Velich, J., Asadi-Bari, T., Hoop, J. A., & Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine*, 124, 246-256. <https://doi.org/10.1016/j.socscimed.2014.11.051>



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Greenspace interventions

- Hunter et al., (2015)
- Findings were confirmed in a future review (Hunter et al., 2019).
- It is *near impossible* to conduct randomised controlled trials of the effects of greenspace improvement on PA.
- It is difficult to know if you are encouraging new visitors to be more active, displacing already-active visitors, or increasing the activity of already-active visitors (and thus, potentially widening inequalities).

Hunter, R. F., Christian, H., Doornik, M., Wheeler, B. W., Strrett, D., Neuenhulsen, M. J., & Braubach, M. (2019). Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environment International*, 130, 104625. <https://doi.org/10.1016/j.envint.2019.104625>



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Greenspace interventions

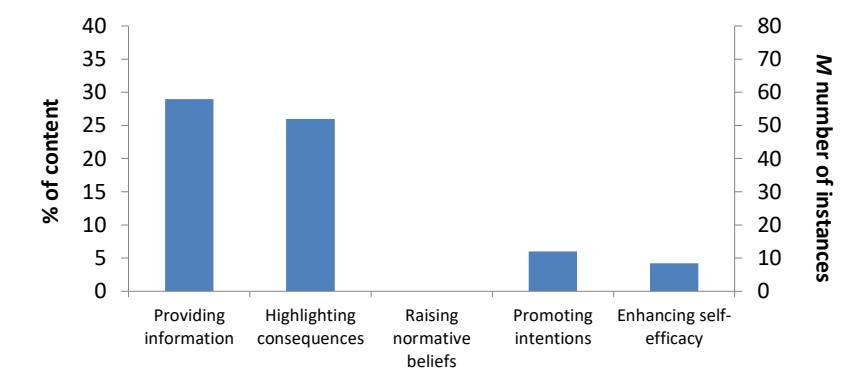
- Elliott et al., (2016)
- Convenience sample of Devon walking leaflets
- Developed coding scheme based on theoretically-informed techniques which have been used to promote PA behaviour change - 5 superordinate categories; 87 subordinate categories.
- 5,099 instances of coded text
- 33/87 potential categories of persuasive message were present in >3 brochures

Elliott, L. R., White, M. P., Taylor, A. H., & Abraham, C. (2016). How do brochures encourage walking in natural environments in the UK? A content analysis. *Health Promotion International*, 33(2), 299-310. <https://doi.org/10.1093/heapro/daw083>



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Greenspace interventions



• Lack of latter three superordinate categories = only appeals to experienced walkers. Elliott, L. R., White, M. P., Taylor, A. H., & Abraham, C. (2016). How do brochures encourage walking in natural environments in the UK? A content analysis. *Health Promotion International*, 33(2), 299-310. <https://doi.org/10.1093/heapro/daw083>

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Greenspace interventions


• Elliott et al., (2020)




Elliott, L. R., White, M. P., Fleming, L. E., Abraham, C., & Taylor, A. H. (2020). Redesigning walking brochures using behaviour change theory: Implications for walking intentions in natural environments. *Health Promotion International*. <https://doi.org/10.1093/hpi/daaa150>


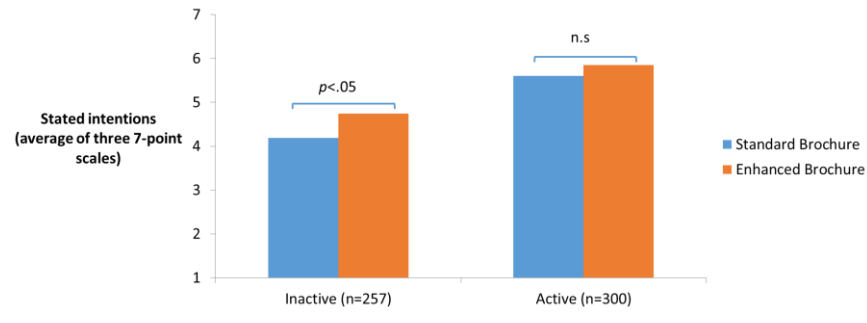
Greenspace interventions

• Elliott et al., (2020)

Elliott, L. R., White, M. P., Fleming, L. E., Abraham, C., & Taylor, A. H. (2020). Redesigning walking brochures using behaviour change theory: Implications for walking intentions in natural environments. *Health Promotion International*. <https://doi.org/10.1093/hpi/daaa150>


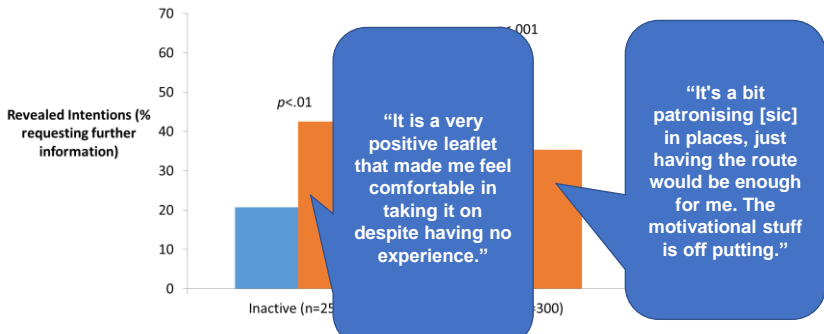
Greenspace interventions

Group	Standard Brochure	Enhanced Brochure
Inactive (n=257)	~4.2	~4.8
Active (n=300)	~5.5	~5.8

Elliott, L. R., White, M. P., Fleming, L. E., Abraham, C., & Taylor, A. H. (2020). Redesigning walking brochures using behaviour change theory: Implications for walking intentions in natural environments. *Health Promotion International*. <https://doi.org/10.1093/hpi/daaa150>

Greenspace interventions


Group	Standard Brochure	Enhanced Brochure
Inactive (n=257)	~20	~42
Active (n=300)	~35	~38

“It is a very positive leaflet that made me feel comfortable in taking it on despite having no experience.”

“It’s a bit patronising [sic] in places, just having the route would be enough for me. The motivational stuff is off putting.”


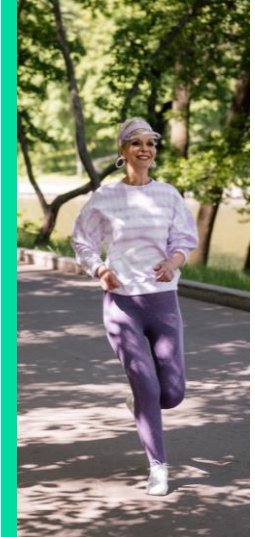
Elliott, L. R., White, M. P., Fleming, L. E., Abraham, C., & Taylor, A. H. (2020). Redesigning walking brochures using behaviour change theory: Implications for walking intentions in natural environments. *Health Promotion International*. <https://doi.org/10.1093/hpi/daaa150>

Greenspace interventions evidence summary



- Observing effects of greenspace interventions on physical activity is difficult.
 - Randomised controlled design are rarely possible.
 - It is often difficult to attribute effects to the intervention.
 - The effects may take a very long time to appear (more than your constrained study time).
- Solutions:
 - Clever use of very good administrative/commercial data longitudinally.
 - Greater funding for longer/stronger research designs.
- Carefully designed promotional efforts may be key.
 - ...but getting people to engage with promotional efforts is another matter.
- Connswater community greenway: <https://youtu.be/BzuUPerwmAc>

...and finally

Economic evaluation



Table 4
Implications for health and welfare from 'active visit' to natural environments by 'active individuals' in England (2009/10-2014/15)

Self-reported exercise a week	Active visits last week	Number of individuals		QALY value		QALYs (per year)		Annual welfare gain in £	
		N	(95% CI)	Pre-visit	N	(95% CI)	£ (QALY = £20,000)	N	(95% CI)
>5 x 30 min	2	998,013	(11,496)	0.001007	30,534	(12)	206,577,013	(2,417,401)	
	3	452,366	(8,019)	0.001514	8,629	(26)	162,295,546	(17,692,077)	
	4	251,809	(5,038)	0.002303	8,108	(30)	162,161,080	(6,090,395)	
3-5 x 30 min	2	175,833	(6,098)	0.002707	7,098	(25)	190,180,203	(17,998,447)	
	3	1,087,133	(44,625)	0.001384	33,775	(230)	1,075,539,633	(47,645,383)	
	4	376,433	(14,428)	0.001844	30,136	(123)	602,274,413	(27,146,736)	
<3 x 30 min	2	3,201,332	(75,762)	0.000384	305,164	(379)	2,183,210,993	(75,788,192)	

- White et al., (2016)
- Average annual health cost savings resulting from visits to nature which incurred at least 30 minutes of moderate-intensity physical activity equates to £2.2bn.
- £314m from just water sports (Papathanasopoulou et al., 2016).



White, M. P., Elliott, L. R., Taylor, T., Wheeler, B. W., Spencer, A., Bome, A., Depledge, M. H., & Fleming, L. E. (2016). Recreational physical activity in natural environments and implications for health: A population based cross-sectional study in England. *Preventive Medicine*, 91, 383-388. <https://doi.org/10.1016/j.ypmed.2016.08.012>

Papathanasopoulou, E., White, M. P., Hatters, C., Larkin, A., Harvey, A., & Spencer, A. (2016). Valuing the health benefits of physical activities in the marine environment and their importance for marine spatial planning. *Marine Policy*, 63, 144-152. <https://doi.org/10.1016/j.marpol.2015.10.009>

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Summary

- Greater availability of, accessibility of, and contact with greenspace is associated with higher physical activity attainment.
 - But under certain circumstances for certain people.
- Being active in greener areas confers additive psychological benefits when compared with urban areas.
 - But beware measurement issues.
- Improving greenspace can increase physical activity levels.
 - But we are unsure who for, and promotion efforts are key (and beware boomerang effects / gentrification).
- Greenspaces are a public health resource for physical activity which could lead to substantial health cost savings.



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Stuff I couldn't even cover!

- Some evidence that the associations between greenspace availability and physical activity are stronger for people living on lower household incomes (Garrett et al., 2020).
 - Implications for inequalities.
 - ...but effects did not extend to accelerometer-measured physical activity.
- Mixed / early evidence for the benefit of nature-based physical activity programmes for therapeutic gain (e.g. Britton et al., 2018)
 - Research design / funding issues.
 - ...watch this space.

Garrett, J. K., White, M. P., Elliott, L. R., Wheeler, B. W., & Fleming, L. E. (2020). Urban nature and physical activity: Investigating associations using self-reported and accelerometer data and the role of household income. *Environmental Research*, 190, 108950. <https://doi.org/10.1016/j.envres.2020.108950>

Britton, E., Kindermann, G., Dornegan, C., & Carlin, C. (2018). Blue care: A systematic review of blue space interventions for health and wellbeing. *Health Promotion International*, 20. <https://doi.org/10.1093/heapro/day103>

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Nature, health, and well-being CPD course

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Lewis Elliott (L.R.Elliott@exeter.ac.uk)

FUSE Physical Activity Workshop 2023



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