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A Systematic Review and Meta-Analysis of the Relationships between Pro-Environmental Behaviours

Anda-Bianca Ciocirlan, Harriet Baird & Richard Rowe

University of Sheffield, School of Psychology, ICOSS Building, 219 Portobello, Broomhall, Sheffield, S1 4DP, United Kingdom

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Abstract

An understanding of the relationships between pro-environmental behaviours can enable researchers to develop more holistic approaches to encourage sustainable practices and support the design of interventions that can target multiple behaviours. The present review examines the relationships between different pro-environmental behaviours. We searched Scopus, PsycInfo, and GreenFILE, conducted forward and backward citation searches, and contacted authors of included studies for expert recommendations. Twenty-six empirical studies that measured at least two pro-environmental behaviours at an individual or household level were included, which provided 1,888 correlations between pro-environmental behaviours. Random-effects meta-analysis with Robust Variance Estimation (RVE) found a small overall effect size between pro-environmental behaviours ($r = 0.16$, 95% CI = [0.08, 0.24]). Associations were observed both between behaviours from distinct domains of pro-environmental behaviour (e.g., energy conservation and water conservation), and within the same domain (e.g., energy conservation behaviours such as turning off lights and using efficient appliances). Behaviours that belonged to the same general domain were more strongly correlated than behaviours from distinct domains (e.g., energy conservation behaviours, $r = 0.24$, 95% CI = [0.06, 0.43]; resource management behaviours, $r = 0.23$, 95% CI = [0.11, 0.37]). In contrast, behaviours from distinct domains showed weaker associations, such as the correlation between energy conservation and civic actions ($r = 0.11$, 95% CI = [0.06, 0.16)]. These findings suggest that there may be an underlying pro-environmental behaviour factor that interventions could target with the potential for effectiveness across multiple behaviours. This approach may increase intervention efficiency by targeting multiple behaviours simultaneously, maximising environmental impact while reducing resource expenditure.

Keywords: pro-environmental behaviour, correlations, behavioural framework, environmental impact, intervention recommendations

Introduction

Addressing environmental challenges requires an understanding of human behaviour because many environmental problems are directly linked to the actions, decisions, and consumption patterns of individuals, communities, and organisations. For example, human behaviour is

considered one of the main drivers of climate change, contributing to rising temperatures, ecosystem disruption, biodiversity loss, and extreme weather events, such as floods, droughts, and wildfires (Abbass et al., 2022; Clarke et al., 2022). Behaviour change is required to achieve positive environmental change, but promoting behaviour change would benefit from understanding how different behaviours are related. For instance, individuals who drive electric vehicles might also be more likely to install solar panels. Similarly, a relationship may exist between reusing containers (e.g., for food and drink) and recycling, especially since both are ways to manage waste. Typically, environmental psychologists and researchers study behaviours in isolation, overlooking the relationships between different pro-environmental behaviours. Identifying the relationships between pro-environmental behaviours, can inform the design of interventions in order to maximize spillover effects, and address multiple behaviours simultaneously, thereby enhancing the overall environmental impact of the intervention.

Previous research suggests that there are associations between some pro-environmental behaviours. For instance, buying sustainable products was positively associated with other pro-environmental behaviours, such as recycling, use of public transport, and saving water (Lanzini & Thøgersen, 2014). While these findings suggest there are relationships between some pro-environmental behaviours, they are often limited to discrete types of pro-environmental behaviour, and for some behaviours, the findings are conflicting. For example, while some studies have found that water and energy conservation are positively correlated (e.g., Ballew, 2019), other studies have not found any significant correlations (e.g., Sanguinetti et al., 2022). To our knowledge, no review to date has systematically investigated the holistic network of relationships across a full range of pro-environmental behaviours. Understanding these relationships would provide several important benefits, such as identifying behaviours that co-occur, identifying a core pro-environmental behaviour that has significant relationships with a wide range of other pro-environmental behaviours, predicting spillover effects, and informing interventions that maximise environmental impact by targeting multiple behaviours at the same time. Given these benefits, the aim of the current review is to conduct a comprehensive systematic review and meta-analysis of the relationships between pro-environmental behaviours.

Understanding and conceptualising pro-environmental behaviour

Pro-environmental behaviour is typically defined as any behaviour that contributes to environmental sustainability by minimising environmental harm or even benefiting the environment (Steg & Vlek, 2009). Pro-environmental behaviour can differ on a number of dimensions, including the type of behaviour (e.g., consumption, waste management, energy use) and the motives underlying the behaviour (e.g., health, financial, environmental).

While no single framework encompasses all types of pro-environmental behaviours categorised based on the same criteria, several studies contributed to their categorisation, using different criteria such as environmental impact (e.g., Wynes & Nicholas, 2017; Ivanova et al., 2020). Some

frameworks refer to specific pro-environmental behavioural domains or contexts, such as those proposed by William and Dair (2007), who focused on sustainable behaviours that can be enabled through the design of neighbourhood-scale developments (e.g., sustainable transport use and energy-efficiency). Others attempted to rank behaviours based on their carbon emissions. For example, Wynes and Nicholas (2017) classified behaviours into three groups: (i) high impact (e.g., having one less child, living car free, eating a plant-based diet, buying green energy), (ii) moderate impact (e.g., recycle, hang dry clothes), and (iii) low impact (e.g., upgrade light bulbs). Although their aim was not to create a framework for pro-environmental behaviour, Wynes and Nicholas (2017) provided a valuable starting point for framework development through their systematic approach to classifying behaviours based on environmental impact.

Building on the work of Wynes and Nicolas (2017), Ivanova et al. (2020) reviewed more recent evidence to provide an updated and comprehensive assessment of the mitigation potentials (i.e., the extent to which actions can reduce greenhouse gas emissions) associated with household-level consumption options within the domains of food, housing, and transport, based on greenhouse gas emissions. The most impactful pro-environmental behaviours identified were living car free (in the transportation domain), adopting a vegan diet (in the food domain), and using renewable energy (in the housing domain). Although the review by Ivanova et al. (2020) was more limited in scope, it supported the findings of Wynes and Nicholas (2017) regarding the most impactful behaviours in the domains that were analysed. Similarly, Ivanova et al. (2020) aimed to identify impactful pro-environmental behaviours rather than creating a comprehensive framework, but their systematic analysis and classifications can lay the foundation of a more holistic framework for understanding pro-environmental behaviour.

With respect to the different motives underlying people's decisions to engage in pro-environmental behaviour, some sustainable behaviours may be driven by environmental motives (i.e., influenced by concerns about the environment and intentions to help preserve the environment), whereas other pro-environmental behaviours may be driven by different motives. For example, an individual may act in a more pro-environmental way in order to improve their health, but doing so also reduces their environmental impact. This could be the case for adopting a vegan diet as it is associated with many positive health outcomes (Selinger et al., 2023) while also being considered a more sustainable dietary choice (Chai et al., 2019). While the health motivation may be the driver of adopting vegan diets for some individuals, the environmental impact of such diets remains positive, and therefore such actions can be considered pro-environmental behaviours. Similarly, individuals may make financial decisions with the intention to reduce their spending, which can also have a positive environmental impact. For example, buying second-hand clothes does not only save money, but it also has a high environmental impact, as reusing textiles has a much lower environmental impact than buying new clothes (Farrant et al., 2010). Another common example is engaging in active transportation (i.e., transportation that is human-powered, such as walking and cycling), which is a sustainable choice that can often be determined by concerns for health and

fitness (e.g., Teuber & Sudeck, 2021). These arguments suggest that pro-environmental behaviours should be determined based on their impact on the environment, rather than the underlying behavioural motivation (Nielsen et al., 2021). Thus, the present review will consider all examples of pro-environmental behaviour, however, we will also explore whether the different motives underlying the behaviours of focus has an impact on the size of the associations between different behaviours (e.g., two behaviours that are driven by the same underlying motive, may be more strongly associated than behaviours driven by different motives).

The importance of exploring the relationships between pro-environmental behaviours

Understanding the relationships between pro-environmental behaviours can have a number of benefits for furthering our theoretical understanding of behaviour central to environmental psychology, and in the design and evaluation of interventions designed to promote more sustainable behaviours and help tackle environmental challenges.

First, exploring the associations between pro-environmental behaviours might reveal how different pro-environmental behaviours cluster together. If clusters of behaviours are identified, then further research can investigate whether there are shared underlying factors that explain these clusters (e.g., someone who recycles consistently may also be likely to conserve water, suggesting a shared value for environmental protection). Identifying clusters of behaviours has been studied in other fields, such as health psychology, to map behavioural clusters and investigate shared underlying determinants. For example, Nudelman and Shiloh (2015) developed a taxonomy of health behaviours, and identified four clusters of health behaviour that included risk avoidance, nutrition, health maintenance, and general wellbeing. Once clusters of behaviour have been identified, then hypotheses can be made regarding the shared motivations and values possibly underlying these behaviours (e.g., Nudleman and colleagues note that risk avoidance behaviours likely share the same goal of minimising harm). In health psychology, behaviours are typically driven by concerns related to health outcomes However, the methodological approach of identifying behaviours that co-occur can be applied iin the context of pro-environmental behaviour. they might reveal common drivers, such as concerns about health or finances, and help identify behaviours that tend to co-occur due to these shared drivers.

Second, exploring the relationships between pro-environmental behaviours may help to identify core behaviours, which are behaviours that have a number of significant relationships with other behaviours (Nudelman et al, 2019). Again, this has been applied in health psychology, where Nudelman et al., (2019) used network analysis to investigate the central nodes of 37 health behaviours and found that nutrition and sleep were core health behaviours due to their strong associations with a range of other health-related behaviours. It is possible that there are core pro-environmental behaviours that serve as central nodes within the broader network. As the approach followed in this review is correlational, the core behaviours may not necessarily influence other behaviours, but their centrality may reflect shared underlying drivers or latent

constructs. Identifying core behaviours can help inform future intervention priorities. Targeting core behaviours may help to increase the overall effectiveness and impact of interventions. For example, if recycling is found to be a core pro-environmental behaviour, then an intervention targeting recycling might also lead to positive changes in behaviours related to energy conservation and sustainable transportation.

Third, and related to the above, understanding how pro-environmental behaviours are related may have important implications for the overall effectiveness of an intervention. That is, how would a local authority judge the effectiveness of an intervention that successfully reduced littering, while also reducing the extent to which people recycled? While this review focuses on associations rather than causal relationships, identifying how behaviours are related can provide hypotheses regarding unintended co-occurring behavioural changes that may follow an intervention. To more accurately evaluate the success of a behaviour change initiative, it is therefore important to understand how interventions aimed at changing one behaviour can also influence other behaviours. .

Behavioural spillover effects occur when engaging in one behaviour influences the probability of engaging in another behaviour (Nilsson et al., 2016)r. Positive spillover occurs when engaging in one behaviour increases the probability of engaging in another behaviour (e.g., an intervention focused on increasing reuse of towels in a hotel led to increased energy savings through turning lights off; Baca-Motes et al., 2012), while negative spillover occurs when the probability is decreased (e.g., an intervention focused on lowering water use led to an increase in energy use; Tiefenbeck et al., 2013). Spillover is an important consideration for the development of interventions designed to promote pro-environmental behaviours, as the effectiveness of an intervention on the overall environmental impact may not be accurately captured if negative spillover is present. If behaviours are investigated in isolation, then important spillover effects may be overlooked. Even if an intervention does not specifically target multiple behaviours, it is important to consider its impact not only on the target behaviour but also on other associated behaviours. If water and energy use are related and an intervention targets water use, it may inadvertently also lead to changes in energy use (e.g., a hot water saving intervention led to a decrease in energy consumption for room heating and a decrease in cold water consumption; Goetz et al., 2021). Conversely, if water use decreases but energy use increases, the intervention will be considered successful in isolation but would fail to achieve the intended overall environmental impact. However, it has been suggested that negative spillover may be less common than positive spillover in pro-environmental behaviours (Truelove & Nugent, 2020). As it would not typically be practical or feasible for researchers to measure the impact of their interventions on all pro-environmental behaviours, having a theoretical understanding of the relationships between different pro-environmental behaviours can highlight when and where spillover effects may occur.

Exploring factors that influence the relationship between pro-environmental behaviours

If significant relationships between pro-environmental behaviours are observed, then the present review will also explore why these relationships may exist through a quantitative analysis of theoretical and methodological moderators. For instance, an important theoretical moderator to consider is the influence of different motivations for engaging in different pro-environmental behaviours. Behaviours driven by pro-environmental motives may be more strongly correlated than behaviours driven by other motives (e.g., health, financial). For example, if both behaviours are driven by the same motivators, then it may be possible that the relationships are stronger than for behaviours driven by different motivators. This idea aligns with research suggesting that shared underlying motivations, such as altruism or environmental attitudes, can act as unifying factors that enhance the likelihood of engaging in multiple related pro-environmental behaviours (Thøgersen & Crompton, 2009). Psychological theories like self-identity and cognitive consistency (Festinger, 1957) can help explain these associations. Engagement in one pro-environmental behaviour can influence people's self-perception, leading to them viewing themselves as environmentalists, which increases the probability that they will act in line with that salient identity. For instance, Whitmarsh and O'Neill (2010) found that self-identity of "carbon offsetter" was a strong predictor of general pro-environmental behaviour, but when exploring specific pro-environmental behaviours, self-identity was a strong predictor for only some of them (i.e., waste reduction, regular water and domestic energy conservation, and eco-shopping and eating), suggesting that there are important nuances here that need to be explored. An example of methodological moderator is the type of measure used to assess pro-environmental behaviour. Studies often rely on self-report measures, which can introduce biases, such as social desirability bias, leading participants to overreport pro-environmental behaviours, and to inflated effect sizes (Kormos & Gifford, 2014). In contrast, objective measures, such as utility bills for energy use or direct observation of recycling habits, provide more reliable data. These methodological differences are expected to moderate the relationships between behaviours because self-reports may artificially enhance the strength of correlations compared to more objective measures. As such, the present review will contribute important insights with respect to why and when different pro-environmental behaviours are correlated.

The Present Review

The current review aims to understand the relationship between a wide range of different pro-environmental behaviours. A previous systematic review by Maki et al. (2019) investigated spillover effects between pro-environmental behaviours (i.e., whether engaging in one behaviour influences the likelihood of engaging in another). Building on this work, the present review seeks to identify broader patterns of association between behaviours. By identifying these patterns, this review seeks to inform our understanding of pro-environmental behaviour (e.g., by identifying core behaviours, or clusters of behaviours), and the design and evaluation of interventions that promote pro-environmental behaviour.

Based on the findings of Wynes and Nicholas (2017) and Ivanova et al. (2020), a framework was developed for the purpose of this review to aid in the identification and categorisation of pro-environmental behaviours into thematic categories. Wynes and Nicholas (2017) grouped behaviours into high, moderate, and low impact behaviours, while Ivanova et al. (2020) focused on three main domains: food, housing, and transport. These classifications were not adopted in the present review as their approach was informed by environmental impact and is limited in scope, not fully capturing the full range of pro-environmental behaviours that was found across the literature reviewed. All the behaviours identified in these two studies were extracted and grouped thematically for the purpose of this review, resulting in a framework consisting of seven domains of pro-environmental behaviour: (i) sustainable transportation, (ii) sustainable food consumption, (iii) energy conservation, (iv) water conservation, (v) resource management, (vi) civic actions, and (vii) family planning. These seven domains served as the starting point for categorising behaviours in the present review, but the framework was expanded and adapted as needed to capture the empirical evidence reviewed. By doing so, the current review contributes towards developing a more comprehensive framework of pro-environmental behaviour that can be used and adapted in future studies and reviews of pro-environmental behaviour.

The current systematic review aims to investigate the relationships between different domains of pro-environmental behaviour, at two different levels: (i) broad domains, represented by a seven-domain framework developed for this review (e.g., sustainable transportation and sustainable food consumption), (ii) specific behaviours within these domains (e.g., reducing flights and reducing meat intake). This has a number of advantages. First, it is possible that behaviours that belong to the same pro-environmental behaviour domain are more strongly correlated than behaviours from different domains (e.g., the relationship between recycling and reusing may be stronger than the relationship between recycling and water conservation because the former are both types of resource management). If behaviours belonging to the same domain are positively correlated, then interventions targeting one behaviour might inadvertently promote the other, amplifying overall environmental impact. We seek to investigate this by comparing relationships between behaviours that belong to the same domain with behaviours belonging to different domains. Second, investigating broad domains helps understand the general patterns of associations between behaviours, while focusing on specific behaviours offers a better understanding of the individual relationships that may reveal exceptions to the general patterns observed at the broader level. For instance, at the broad level, investigating energy conservation behaviours may reveal positive correlations within the domain as a whole. However, examining specific behaviours within the domain can help identify which behaviours show stronger or weaker associations (e.g., turning off lights might strongly correlate with turning off appliances but weakly correlate with installing energy-efficient appliances).

The research questions are:

- What pro-environmental behaviours are the most commonly investigated?
- What is the direction and strength of the relationships within and across distinct domains of pro-environmental behaviour?
- Do the nature and size of the relationships vary according to demographic (e.g., age, gender, type of sample), theoretical (e.g., behaviour determinant, such as financial, health or environmental reasons), and methodological moderators (e.g., study design, measure type)?

Methods

Open science practices

The present systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Page et al., 2021) and with respect to recent recommendations for conducting correlational meta-analyses, such as using robust variance estimation to handle multiple effect sizes from the same study (e.g., Tanner-Smith et al., 2016). The systematic review protocol has been pre-registered on the Open Science Framework (see "Systematic review pre-registration" accessed via https://osf.io/3vce6/). The study materials can be found in the same online repository, including the data for this review, the coding framework, and additional details about the statistical analyses. Data was analysed using RStudio 4.4.1 and the analysis code was uploaded in the project repository (see "R code" accessed via https://osf.io/xvadw).

Eligibility criteria

To be eligible for inclusion studies needed to (i) report a quantitative empirical study, (ii) measure at least two pro-environmental behaviours (any measure of pro-environmental is eligible for inclusion, including self-report and behavioural measures), (iii) report the correlation between at least two pro-environmental behaviours, provide the statistical information for the correlation to be calculated, or the authors have responded to the request to provide the information, and (iv) investigate behaviours at an individual or household level. For intervention studies, only pre-intervention data were considered to ensure that the correlations reflect natural behavioural associations rather than effects induced by the intervention.

The present review excluded (i) reviews or qualitative studies, (ii) studies that do not contain measures of pro-environmental behaviour (e.g., studies that use behavioural intentions or motivation to engage in a behaviour as a proxy for actual behaviour), (iii) studies focusing on the behaviours of broader entities, such as institutions, companies, cities, or countries, and (iv) studies where individuals may be in restrictive settings (e.g., patients with specific conditions requiring adherence to a restrictive diet, or farmers needing to follow laws and regulations). The latter decision was made in order to focus on behaviours where individuals have the autonomy to

choose pro-environmental behaviours, rather than behaviours predetermined by external constraints. This ensures that the behaviours analysed reflect voluntary decisions, which can be targeted using behaviour change techniques. Any unpublished work that was captured by the information sources used was included if it satisfied the eligibility criteria.

Information sources

Three main search strategies were employed in the present review. First, studies were identified by searching three online databases: Scopus (scopus.com), PsycInfo (apa.org/pubs/databases/psycinfo), and GreenFILE (ebsco.com/products/research-databases/greenfile) on the 2nd February 2024. Scopus is a large database of peer-reviewed multidisciplinary research, ensuring a diverse collection of academic literature, while PsycInfo is focused on psychological and behavioural science, and GreenFILE is focused on sustainability. Second, forward and backward searches were conducted for those articles eligible for inclusion. Forward searches involved reviewing articles that cited the studies included in the review, while backward searches focused on examining the reference lists of the included articles. Finally, the authors of the included studies were contacted, informed that one of their studies is eligible for inclusion in the review, and provided with the inclusion criteria. They were then asked if they were aware of any other relevant published or unpublished research.

Search strategy

Building on previous research (e.g., Wynes & Nicholas, 2017; Ivanova et al., 2020), seven domains of pro-environmental behaviour were identified, and a number of search terms were used to reflect each domain of pro-environmental behaviour (i.e., transportation behaviour, eating behaviour, energy conservation, water conservation, resource management, family planning, and civic actions). The keywords used to capture each domain can be found in Table 1. To identify studies that investigate multiple behaviours, search terms representing two different behaviour domains were combined. For example, terms related to sustainable transportation were paired with those related to energy conservation to find studies investigating both, resulting in all the combinations of two different domains being captured. A participant term was added to ensure the search captures only studies investigating human behaviour as conducting the searches without the participant term led to many irrelevant articles from other disciplines being identified that did not focus on human behaviour, such as engineering, energy, and materials science. No language or date restrictions were applied for the initial search. The detailed search strategy for each database is in Appendix A (Supplementary Materials).

Table 1: Keywords used for database searches according to pro-environmental domain

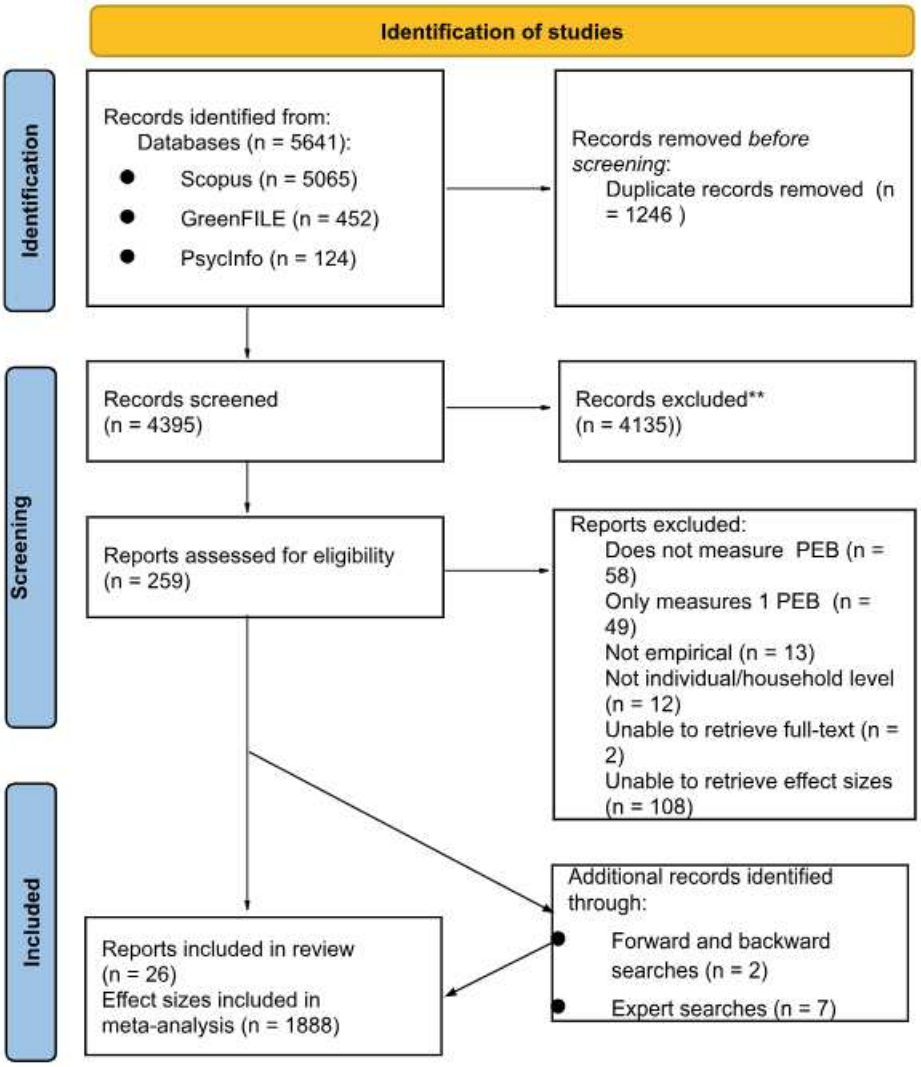
Domain	Search Terms
Transportation behaviour	"sustainable transport*" or "eco-friendly transport*" or "reduce car" or "lower car" or "active transport*" or "sustainable travel*" or "sustainable mode* of transport*" or "electric vehicles" or "public transport*" or “carpooling” or “reduce flight*” or “reduce air travel” or “air travel” or “flights”
Eating behaviour	“Meat consumption” OR “vegetarian*” or “vegan*” or “meat intake” or “meat” or “dairy” or “sustainable food*” or “ecological food*” or “flexitarian*”
Energy conservation	“Energy conserv*” OR “energy saving” OR “saving energy” OR “green energy”
Water conservation	“Water conservation” OR “sav* water” OR “water efficiency”
Resource management	“Reuse plastic” OR “recycle plastic” OR “reduce plastic” OR“ plastic alternative” OR “plastic prevent*” OR “plastic substitute*” OR “bioplastic” OR “plastic” OR “resource* manage*”
Family planning	"Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood"
Civic actions	“environmental education” OR “education for sustainability” OR “sustainab* education” OR “eco-activism” OR “sustainab* activism” OR “sustainab* donations” OR “sustainab* campaign*”
Participant term	“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”

Selection process

A total of 5,641 articles were initially found. Duplicate articles were removed using SR-Accelerator (https://sr-accelerator.com/#/) and EndNote (https://endnote.com/) software. A total of 4,395 papers remained after removing duplicates.
Eligible studies were identified in two steps: (i) title and abstract screening and (ii) full-text screening. Title and abstract screening was conducted, leaving a total of 259 articles for full-text screening.

In the second phase, a random sample of approximately 10% of the full-texts were independently reviewed by two of the researchers (ABC and HMB). The initial agreement rate was 96%, (Cohen kappa = 0.92) indicating almost perfect agreement (Landis & Koch, 1977). This suggests that the inclusion and exclusion criteria were applied consistently. The disagreement was due to translation inconsistencies on a study reported in a foreign language, and was resolved through discussion. After full-text screening, 17 studies were included in thereview. An additional 10 records were identified via the other search methods (see Figure 1 for the PRISMA diagram).

Figure 1: PRISMA Diagram



n = number of articles

Data collection process

A data extraction form was developed (see "Studies and data extraction form" accessed via https://osf.io/3vce6/) to extract: (i) study details: authors, year of publication, study country, and

study design (ii) sample details: type of sample, sample size (*N*), age, gender, country of participants, (iii) behaviour details: the specific behaviours investigated, behavioural domains, whether the correlation is between behaviours belonging to different domains or within the same domain, the property of the behaviour measured (i.e., occurrence, intensity, frequency, duration), motive inference (i.e., primarily environmental, possibly environmental, other reasons), measure type, and information about the specific measure used, (iv) statistical details: effect size and reliability. The Fisher's z transformation and the variance were calculated subsequently using the Excel formula =FISHER(x) for the former and $1/(N-3)$ for the latter.

The data was extracted by the primary researcher (ABC). A random sample of 10% of the studies were then independently coded by a second researcher (HMB) to ensure reliability. The initial agreement rate was 93%, with Cohen's kappa = 0.88, suggesting almost perfect agreement (Landis & Koch, 1977). The disagreements were due to one rater missing some information from one of the studies, and was resolved upon discussion.

Coding pro-environmental behaviours

The behaviour framework initially incorporated seven domains of pro-environmental behaviour, informed by previous research (e.g., Wynes & Nicholas, 2017). However, the framework was flexible, and was updated as needed to accommodate new domains, if any behaviours were identified from the empirical studies that could not fit any of the domains. Similarly, if no behaviours were identified for one of the initial domains, then these were discarded. This resulted in a six domain framework, as family planning was discarded and no new domains were identified. Four of the behaviours fit multiple domains (advanced efficiency, green gardening, green landscaping, and maintenance and management were considered cross-domain). Given that the aim of the present review was to explore correlations across broad and specific behaviour domains, each of the six domains were later split into more specific domains. For instance, resource management was split into green purchasing, recycling, reusing, reducing, composting, and not littering. To ensure the reliability of the framework, two researchers independently coded all the behaviours identified at two levels: (i) the main domain: each behaviour was coded into one of the six main domains, (ii) the specific domain: each behaviour was coded into one of the specific domains within the main domain). The inter-rater agreement was 94% for the main domains and 78% for the specific domains. Cohen's kappa was $k = 0.81$ for the main domains and $k = 0.73$ for the specific domains, indicating almost perfect agreement for the former, and substantial agreement for the latter (Landis & Koch, 1977). Any disagreements were resolved through discussion and consultation of a third researcher. All the decisions were recorded in a spreadsheet (see "Grouping PEBs" accessed via https://osf.io/3vce6/). See Table 2 for the final framework, containing the main and the specific domains of pro-environmental behaviour, their definitions and examples of items.

Table 2: Framework of pro-environmental behaviour

Main domain (n)	Specific domain (n)	Definition of specific domain	Examples
Sustainable transportation (10)	Flying (3)	Reducing or eliminating flights	Avoiding long-distance flights
	Using public transport (4)	Using public transportation (e.g., train, bus)	Taking the bus or train to work
	Active travel (2)	Walking and cycling	Walking
	Car (1)	Reducing or eliminating car use	Purchasing less fuel consuming car
Sustainable food consumption (6)	Animal products (4)	Making dietary changes that include reducing or eliminating animal products	Avoiding eating meat
	Sustainable food purchase (1)	Buying food products that are environmentally friendly	Buying organic milk
	Managing food waste (1)	Monitoring and managing food usage	Reusing food leftovers
Energy conservation (19)	Choosing electricity efficient appliances (12)	Choosing to install devices and appliances that reduce electricity consumption	Install solar panels
	Sustainable use of appliances (5)	Using appliances and devices in a way that reduces electricity consumption (e.g., reducing use)	Turning off air conditioner when going out
	Reducing energy use (1)	Changing behaviours in order to reduce energy consumption	Reducing domestic energy consumption
	Monitor electricity consumption (1)	Monitor household electricity	Monitoring electricity consumption of home

		consumption	appliances
	Renewable energy (11)	Using renewable energy in the household	Using renewable energy sources for heating
Water conservation (13)	Choosing water efficient appliances (2)	Choosing to install devices and appliances that reduce water consumption	Install a water-efficient dishwasher
	Sustainable use of appliances (12)	Using appliances and devices in a way that reduces water consumption	Closing the tap while brushing teeth
	Reducing water use (4)	Changing behaviours in order to reduce water consumption	Have shorter showers
	Efficient irrigation (2)	Reducing water consumption in the garden	Be water-wise in the garden
Resource management (18)	Green purchasing (10)	Buying non-food products that are environmentally friendly	Buy concentrated products
	Recycling (11)	Sorting the waste appropriately and throwing the recyclable waste into a recycling bin	Recycling household waste
	Reducing (5)	Minimising the waste that we produce	Avoid disposable products
	Reusing (7)	Find new purposes for items that otherwise you would throw	Using own bag in store
	Composting (4)	Sorting the organic waste appropriately and using it as a fertiliser	Sorting green kitchen waste for composting
	Not littering (1)	Picking up trash and	Taking garbage when

		not throwing it in spaces that are not designated for waste	leaving public places and throwing it in the trash
Civic actions (5)	Communication/information (2)	Attending to and spreading awareness about environmental issues	Talking about energy saving with other people
	Donation (2)	Donation to an environmental cause or organisation	Donation to an environmental organisation
	Active participation (2)	Behaviours requiring an active effort to contribute to an environmental cause	Participating in activities related to environmental protection

n = number of studies the behaviour appears in

Quality assessment of included studies

To assess the quality of the included studies, three criteria were designed, based on recommendations from Quintana (2015) and criteria used in previous systematic reviews of correlational data (e.g., Baird et al., 2021): (1) an objective measure of pro-environmental behaviour, (2) a sample size of at least 800 (based on a G*power analysis to detect a small effect size; Faul et al., 2009), (3) the measures are internally reliable (alpha > 0.7). Items 1 and 3 were scored from 0 to 3, where 0 represents no mention of the item, and 3 represents explicit description. Item 2 was scored from 0 to 2, where 0 represents a sample size lower than 800 for all effect sizes, 1 represents a sample size higher than 800 for some effect sizes, and 2 represents a sample size higher than 800 for all effect sizes. Total scores for methodological quality could range from 0 to 7, higher scores denoting higher quality of studies.

Effect measures

Pearson's correlation coefficient (*r*) was used as the standard effect size metric. If other effect sizes were reported (e.g., Cohen's d, odd ratios), then these were converted to *r* using an effect size converter (https://www.escal.site/). When the effect size was not reported and the authors provided the raw data, we calculated the correlation coefficient using SPSS. As Pearson's *r* is not normally distributed, Fisher's z-transformed correlation coefficients were used to represent the relationships between different behaviours in the analyses, which were converted back to Pearson's *r* for reporting. Pearson's *r* correlation coefficients were interpreted following Cohen's (1992) recommendations, where an effect size of 0.10 is small, 0.30 is medium, and 0.50 is large.

Meta-analytic strategy

Random-effects meta-analyses with Robust Variance Estimation (RVE; Hedges et al., 2010) were conducted using the *robumeta* package in R Version 4.4.1 (R Core Team, 2023). RVE was used to account for dependencies as multiple effect sizes were extracted from the same samples within many of the studies included in the present review. For instance, Castellini et al. (2023) reported the correlations between sustainable food consumption, energy conservation, green purchasing, recycling and sustainable mobility, resulting in a total of 10 effect sizes extracted from the same sample. Because the relationships between different pro-environmental behaviours are highly variable, a random-effects model was chosen. Between-study heterogeneity was examined through tau-squared (τ^2) and I-squared (I^2) statistics. An I^2 threshold of >75% was considered indicative of substantial heterogeneity, which was further assessed based on funnel plots. Spearman's rho, which represents an estimate of the correlation between effect sizes from the same study, was set at 0.80, the recommended value for when the effect size is not known (Hedges et al., 2010). Further sensitivity analyses were performed to assess the robustness of the findings with Spearman's rho set at different values from 0.10 to 0.80, in 0.10 increments, but the results did not change notably when this value was adjusted. Given this consistency, only the results with rho = 0.80 are reported in the review.

Meta-analyses were performed at two different levels of behaviour specificity. First, meta-analyses were conducted for each pair of main behaviour domains investigated (e.g., resource management, energy conservation, water conservation), resulting in the examination of 21 distinct types of association, both between and within-domains. For example, between-domain associations included the relationship between energy conservation behaviours and water conservation behaviours. Within-domain associations refer to the overall correlations between all behaviours grouped within the same domain, such as energy conservation. These were calculated by meta-analysing all available correlations between distinct behaviours within the same domain, resulting in a single overall correlation estimate per domain. For instance, these analyses provided a single correlation estimate for energy conservation behaviours. Second, meta-analyses focused on specific behavioural domains within these broader categories. For instance, behaviours related to the "resource management" domain were further broken down into specific behaviours such as green purchasing, recycling, and reusing. The associations between these specific behaviours (e.g., the correlation between recycling and reusing) were analysed separately. Then, the effects of demographic, theoretical and methodological moderators were investigated using meta-regression with RVE[1]. The moderator variables were entered into three models based on their type: (i) a model containing only demographic moderators, (ii) a model containing only theoretical moderators, and (iii) a model containing only methodological moderators. Categorical variables were dummy coded before being entered into the regression equation. According to recommendations for RVE (Tipton, 2015), results from models with

[1] These were only explored at the broad level due to a lack of studies.

degrees of freedom less than 4 are considered unreliable so they should be interpreted with caution, as low degrees of freedom can result from a limited number of studies or highly dependent effect sizes.

Publication bias assessment

No publication bias was expected as the aims of the studies to be analysed were not specifically to assess associations between pro-environmental behaviours. Indeed, most of the associations between pro-environmental behaviours were not reported in the studies, and were retrieved from online repositories or by contacting the authors. Therefore, it is not expected that these associations will be higher in published studies than unpublished studies or for the studies to have been more likely to be published due to high associations.

However, the presence of publication bias was formally assessed using funnel plots and Egger's test. Egger sandwich test is a variant of the traditional Egger's regression test that can be employed in meta-regressions using RVE (Rodgers & Pustejovsky, 2021). The Egger sandwich test was performed by using the variance of Fisher's z as a predictor in the metaregression model. The limitations of the Egger sandwich test require the results to be interpreted with caution. It is possible for differences between small and large studies to be due to heterogeneity and not to publication bias. If publication bias is detected through funnel plots and Egger's test, then the PET-PEESE (PET = Precision-Effect Testing; PEESE = Precision-Effect Estimate with Standard Error) method can be applied (Stanley & Doucouliagos, 2013), to detect and adjust for small-study effects. PET evaluates whether the effect sizes in the analysis are systematically associated with their standard errors, which can be indicative of publication bias. Unlike Egger's regression, which focuses on the intercept, PET examines the slope of the relationship between effect size and standard error to determine whether smaller studies with larger standard errors tend to report larger effect sizes, which could suggest the presence of bias. PET tends to underestimate non-zero effects, so it is recommended to also use PEESE as a complementary method to adjust for potential publication bias.

Results

Study characteristics

The systematic review included 26 studies that measured at least two pro-environmental behaviours. All the studies were published from 2006 onwards, with most published (n = 22) in the last 10 years. The studies were conducted across different countries, with the frequencies being USA (n = 9), UK (n = 3), Denmark (n = 2), Spain (n = 2), Malaysia (n = 2), China (n = 2), Germany (n = 1), Italy (n = 1), Portugal (n = 1), Lithuania (n = 1), Finland (n = 1), and Australia (n = 1). Most studies used self-report measures (n = 20), where each behaviour was measured using single item measures (n = 17) or multi-item scales (n = 3). From the behaviours identified,

most were coded as behaviours relating to energy conservation (n = 62), resource management (n = 50) and water conservation (n = 29). The studies most often measured the frequency of the behaviours or their occurrence (n = 24), intensity being measured in only four studies. None of the studies measure pro-environmental behaviour in terms of duration. Most of the studies did not aim to investigate the correlations between pro-environmental behaviours, and therefore did not report the effect sizes, which were later retrieved from online repositories or directly from the authors. The full list of studies and associated characteristics can be found in Appendix B (Supplementary Materials).

Relationship between pro-environmental domains

A total of 1,888 effect sizes were extracted from 26 studies, and 1,872 were retained for analyses as the effect sizes from four behaviours were cross-domain. The main effects meta-analysis found that across all pro-environmental behaviours, the average size of the relationship was small (r = 0.16, 95% Confidence Interval (CI) = [0.08, 0.24]). Heterogeneity was indicated by an I^2 value of 98.98%, which implies that a high proportion of the variance in effect sizes is due to differences between the studies that need to be investigated further (e.g., study design, sample characteristics).

Table 3 reports the results of the meta-analyses conducted for each broad behavioural domain. Separate meta-analyses were run for each pair of associations between the six main behavioural domains, resulting in 21 independent analyses. One analysis was excluded due to an error in processing which occurred because the effect sizes within this pair were not sufficiently varied, leading to a singularity issue in the analysis. Additionally, the degrees of freedom were less than 4 for nine of the pairs, so the results for those analyses may not be reliable.

Positive correlations were found both between distinct domains but also within domains. Energy conservation behaviours were associated with other energy conservation behaviours (r = 0.24, 95% CI = [0.06, 0.43]), but also with water conservation (r = 0.30, 95% CI = [0.09, 0.54]), resource management (r = 0.21, 95% CI = [0.09, 0.33]), and civic actions (r = 0.11, 95% CI = [0.06, 0.16]). Behaviours related to resource management were positively correlated with other behaviours related to resource management (r = 0.23, 95% CI = [0.11, 0.37]), and sustainable transportation was correlated with energy conservation (r = 0.13, 95% CI = [0.05, 0.21]) and resource management (r = 0.13, 95% CI = [0.02, 0.25]).

Table 3: Results of meta-analyses of correlations between broad behavioural domains

*All the behaviours extracted have been coded and grouped into the six domains presented (note that the correlations within the same behavioural domain reflect the association between distinct behaviours that belong to the same domain).

Behaviours*	k(s)	N	df	*r*	95% CI	τ^2	I^2 (%)
Overall effect size	1872(33)	464210	24.7	0.16***	0.08, 0.24	0.03	98.98
Sustainable transportation correlated with…							
Sustainable transportation[a]	17(3)	3527	2	0.27	-0.26, 0.81	0.06	98.53
Sustainable food consumption	18(6)	417598	4	0.15	-0.03, 0.33	0.01	97.25
Energy conservation	58(9)	9242	6.98	0.13***	0.05, 0.21	0.01	92.22
Water conservation[a]	18(5)	3246	3	0.20**	0.02, 0.37	0.02	91.67
Resource management	77(10)	26868	7.99	0.13**	0.02, 0.25	0.02	97.61
Civic actions[a]	15(4)	4993	1.99	0.09	-0.14, 0.33	0.01	91.93
Sustainable food consumption correlated with…							
Sustainable food consumption	3(1)	937	N/A	N/A	N/A	N/A	N/A
Energy conservation[a]	16(4)	5355	3	0.27	-0.27, 0.80	0.11	99.27
Water conservation[a]	9(1)	937	1	0.15***	0.15, 0.15	0	95.30
Resource management[a]	21(4)	5345	3	0.26	-0.31, 0.83	0.13	99.37
Civic actions[a]	3(3)	2592	1	0.01	-0.3, 0.33	0	5.50
Energy conservation correlated with…							
Energy conservation	238(12)	25138	9.97	0.25**	0.06, 0.43	0.05	98.86
Water conservation	313(13)	19486	9	0.31**	0.09, 0.54	0.27	99.57
Resource management	354(16)	45976	13	0.21***	0.09, 0.33	0.03	98.86
Civic actions[a]	41(6)	5784	2.97	0.11***	0.06, 0.16	0.01	90.27
Water conservation correlated with…							
Water conservation	172(7)	17550	4.99	0.16	-0.01, 0.33	0.33	97.48
Resource management	227(9)	35058	6.79	0.13	-0.03, 0.30	0.01	97.47
Civic actions[a]	10(4)	1827	1	0.13	-0.17, 0.43	0.02	85.53
Resource management correlated with…							

Resource management	203(14)	29399	9.99	0.24***	0.11, 0.37	0.07	99.13
Civic actions[a]	56(4)	4993	2	0.16	-0.15, 0.47	0.02	95.16
Civic actions correlated with…							
Civic actions[a]	3(3)	2659	1	0.39	-1.7, 2.47	0.05	97.59

k = number of effect sizes, s = number of independent samples, N = total sample size, df = degrees of freedom, r = correlation coefficient (note that this was converted from Fisher's z after the meta-analysis), CI = confidence interval, τ^2 = measure of heterogeneity (estimated variance of true effect sizes), I^2 = measure of heterogeneity (the percentage of total variation across studies that is due to heterogeneity).

[a] Results are not reliable as df is less than 4.

For "Sustainable food and Sustainable food", the analysis was not completed due to singularity issues, so it is marked as N/A (Not Available).

Signif. codes: < .01 *** < .05 **

Meta-analyses were conducted to examine the relationships between specific subdomains of pro-environmental behaviour (e.g., green purchasing and recycling). All the results were unreliable (df < 4) as there were insufficient effect sizes for each pair. Therefore these results are not reported further.

Factors that moderate the size of the relationship between domains

We investigated the effect of demographic (i.e., type of sample, age, gender), theoretical (i.e., motive inference), and methodological (i.e., study design, property of behaviour measured, methodological quality) moderators using meta-regressions with Robust Variance Estimation. Country of participants and measure type (i.e., self-report, behavioural, and outcome) could not be used in the analysis because of insufficient studies in each group.

Table 4 displays the full results of the meta-regressions[2]. The demographic and the theoretical moderators did not have a significant effect on the relationship between pro-environmental behaviours. However, the present review did observe differences according to methodological moderators. The correlations were significantly stronger when an observational design was used, compared to experimental design (B = 0.22, 95% CI =[0.10, 0.35]). The property of the measure of behaviour also had a significant effect on the relationship between behaviours (e.g., whether

[2] Moderation analyses were also conducted for each pair of behaviours investigated. However, the limited number of effect sizes available within individual domains resulted in very low degrees of freedom (df < 4), and as such, it was not possible to draw reliable interpretations.

the measure of behaviour assessed frequency, intensity, or occurrence). When two behaviours were both measured in terms of frequency, the correlation was significantly stronger compared to when the measures of behaviours did not match (e.g., if one behaviour was measured via frequency and another was measured via intensity; $B = 0.20$, 95% CI = [0.05. 0.35]). To explore this difference further, an additional regression model included a variable coding whether the properties of behaviour matched (coded 1) or they did not match (coded 0). The results showed a significant difference between the two categories, suggesting that when the properties match, the effect size is significantly higher than when they do not match ($B = 0.23$, 95% CI = [0.09, 0.38]).

Table 4: Meta-regression with Robust Variance Estimation results

Moderator	b	SE	t	df	95% CI
Demographic moderators					
Intercept[a]	0.44	0.39	1.12	2.78	-0.86, 1.74
Type of sample (ref. General population)					
Households[a]	0.05	0.08	0.69	1.72	-0.34, 0.45
University students	-0.13	0.28	-0.47	5.51	-0.85,0.58
Young adults	-0.10	0.14	-0.72	4.14	-0.47, 0.27
School students	0.14	0.26	0.54	4.55	-0.54, 0.81
Children (<14)[a]	-0.08	0.27	-0.31	3.65	-0.87, 0.70
Age[a]	0	0.01	-0.43	3.27	-0.03, 0.02
Gender (% females)[a]	0	0	-0.57	1.51	-0.02, 0.02
Theoretical moderators					
Intercept[a]	0.13	0.10	1.31	9.68	-0.09, 0.36
Motive inference (ref. Unmatched motive inference)					
Behaviour possibly pro-environmental	0.04	0.10	0.39	13.71	-0.18, 0.26
Behaviour primarily pro-environmental	0.03	0.11	0.27	8.77	-0.22, 0.27

Methodological moderators					
Intercept	-0.10	0.06	-1.67	6.11	-0.25, 0.05
Study design (ref. experimental)					
Quasi-experimental	0.11	NA	NA	NA	NA
Case study	0.63	0.06	0.97	5.48	-0.10, 0.23
Observational	0.22***	0.05	4.06	8.29	0.10, 0.35
Longitudinal[α]	0.10	0.13	0.81	2.20	-0.39, 0.59
Property behaviour (ref. Unmatched properties)					
Occurrence	0.14	0.08	1.82	8.54	-0.04, 0.31
Frequency	0.20**	0.07	3.05	9.70	0.05, 0.35
Intensity	0.39	0.06	0.62	6.11	-0.11, 0.19

The moderators were entered into three models based on the type of moderator: demographic, theoretical, and methodological. Results were based on 19, 26 and 26 studies (1771, 1872, 1872 effect sizes).
CI = confidence interval
[--a] Results are not reliable as df is less than 4.

For "Quasi-experimental" the values are NA due to insufficient data.

Signif. codes: < .01 *** < .05 **

Publication bias

Visual inspection of the funnel plot (see Figure 2) indicated potential publication bias, which was further assessed using Egger's sandwich test. This analysis showed a significant relationship between variance and effect size (B = -25.47, $p < 0.05$), indicating potential publication bias. As Egger's test was significant, we needed to address potential publication bias using PET-PEESE (Stanley & Doucouliagos, 2014). PET was not significant (B = -2.205, $p = 0.126$), indicating that no indicators of publication bias were found. The PEESE model showed a significant negative slope (B = -25.469, $p < 0.05$), indicating some potential bias. The intercept for the PEESE model was also significant (B = 0.233, $p < 0.001$), suggesting a positive effect size after adjusting for bias. The PET-PEESE method was also applied to each one of the meta-analyses.
The full results are displayed in Tables 5 and 6.

Table 5: Detecting publication bias

Behaviours	**Initial REMA with RVE**		**Egger**		**PET**		
	r	95% CI	z	p	B (SE)	95% CI	p
Sustainable transportation correlated with…							
Sustainable transportation[a]	0.27	-0.26, 0.81	-0.30	0.67	36.29	-371.6, 444.1	0.46
Sustainable food consumption	0.15	-0.03, 0.33	0.01	0.86	6.50	-13.50, 26.50	0.28
Energy conservation	0.13***	0.05, 0.21	0.03	0.56	6.05	-3.10, 15.19	0.12
Water conservation[a]	0.19**	0.02, 0.37	0.13	0.63	3.27	-34.2, 40.76	0.74
Resource management	0.13**	0.02, 0.25	0.01	0.84	7.21	3.53, 10.90	0.01
Civic actions[a]	0.09	-0.14, 0.33	-0.02	0.72	7.81	-13.99, 29.61	0.14
Sustainable food consumption correlated with…							
Sustainable food consumption	N/A	N/A	NA	NA	NA	NA	NA
Energy conservation[a]	0.26	-0.27, 0.80	-0.24	0.50	31.87	-5.45, 4.14	0.39

Water conservation[a]	0.15***	0.15, 0.15	NA	NA	NA	NA	NA
Resource management[a]	0.25	-0.31, 0.83	-0.25	0.33	31.07	-121.40, 183.53	0.31
Civic actions[a]	0.01	-0.3, 0.33	0.03	0.08	-1.36	-2.02, -0.71	0.02
Energy conservation correlated with…							
Energy conservation	0.24**	0.06, 0.43	0.27**	0.03	0.16	-27.26, 27.58	0.98
Water conservation	0.30**	0.09, 0.54	0.41**	0.01	-2.59	-11.87, 6.68	0.44
Resource management	0.21***	0.09, 0.33	0.14	0.10	5.76	-2.51, 14.03	0.14
Civic actions[a]	0.11***	0.06, 0.16	0.09	0.07	1	-4.57, 6.56	0.49
Water conservation correlated with…							
Water conservation	0.16	-0.01, 0.33	0.07	0.36	5.32	-9.34, 20	0.17
Resource management	0.13	-0.03, 0.30	0.20	0.07	-1.02	-22.78, 20.75	0.87
Civic actions[a]	0.13	-0.17, 0.43	0.11	0.24	0.58	-12.64, 13.81	0.68
Resource management correlated with…							
Resource management	0.23***	0.11, 0.37	0.26**	0.03	0.24	-17.27, 17.76	0.10

Civic actions[a]	0.16	-0.15, 0.47	0.01	0.81	10.33	2.31, 18.35	0.04
Civic actions correlated with…							
Civic actions[a]	0.37	-1.7, 2.47	0.07	NA	NA	NA	NA

REMA = Random Effects Meta-Analysis, RVE = Robust Variance Estimation, PET = Precision-Effect Testing

[a] Results are not reliable as df is less than 4.

Signif. codes: < .01 *** < .05 **

Table 6: Correcting for Publication Bias

Behaviours	**Initial REMA with RVE**		**PEESE estimate**	
	r	95% CI	B	95% CI
Sustainable transportation correlated with…				
Sustainable transportation[a]	0.27	-0.26, 0.81	-0.30	-6.98, 6.38
Sustainable food consumption	0.15	-0.03, 0.33	0.01	-0.59, 0.61
Energy conservation	0.13***	0.05, 0.21	0.03	-0.1, 0.16
Water conservation[a]	0.19**	0.02, 0.37	0.13	-1.01, 1.27
Resource management	0.13**	0.02, 0.25	0.01	-0.14, 0.16
Civic actions[a]	0.09	-0.14, 0.33	-0.02	-0.48, 0.45
Sustainable food consumption correlated with…				
Sustainable food consumption	N/A	N/A	NA	NA

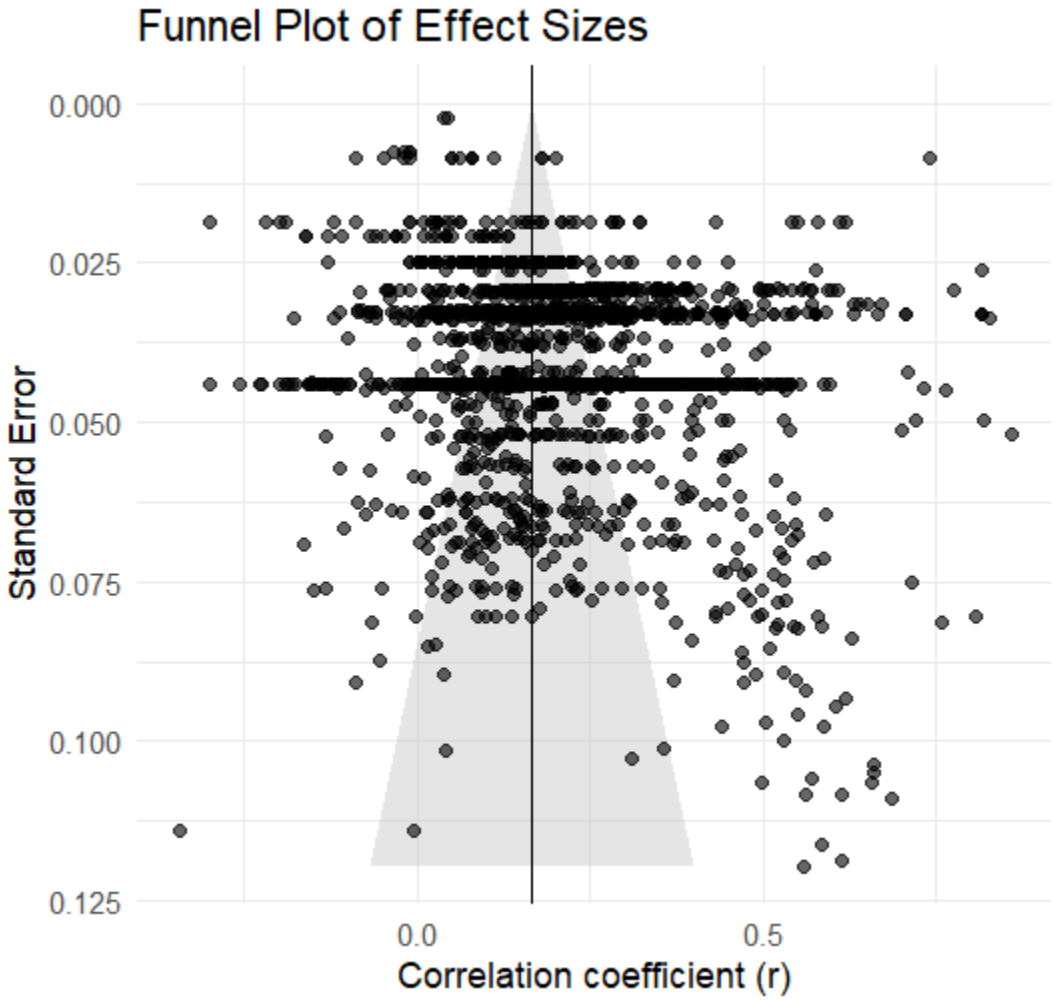
Energy conservation[a]	0.26	-0.27, 0.80	-0.24	-3.07, 2.58
Water conservation[a]	0.15***	0.15, 0.15	NA	NA
Resource management[a]	0.25	-0.31, 0.83	-0.25	-0.93, 1.43
Civic actions[a]	0.01	-0.3, 0.33	0.03	-0.02, 0.07
Energy conservation correlated with…				
Energy conservation	0.24**	0.06, 0.43	0.27	0.04, 0.49
Water conservation	0.30**	0.09, 0.54	0.41	0.12, 0.69
Resource management	0.21***	0.09, 0.33	0.14	-0.03,0.30
Civic actions[a]	0.11***	0.06, 0.16	0.09	-0.02, 0.21
Water conservation correlated with…				
Water conservation	0.16	-0.01, 0.33	0.07	-0.14, 0.28
Resource management	0.13	-0.03, 0.30	0.20	-0.03, 0.42
Civic actions[a]	0.13	-0.17, 0.43	0.11	-0.46, 0.69
Resource management correlated with…				
Resource management	0.23***	0.11, 0.37	0.26	0.04, 0.48
Civic actions[a]	0.16	-0.15, 0.47	0.01	-0.26, 0.27
Civic actions correlated with…				
Civic actions[a]	0.37	-1.7, 2.47	NA	NA

REMA = Random Effects Meta-Analysis, RVE = Robust Variance Estimation, PEESE = Precision-Effect Estimate with Standard Error

[a] Results are not reliable as df is less than 4.

Signif. codes: < .01 *** < .05 **

Figure 2: Funnel plot



Quality assessment

The methodological quality of the included studies was generally low in terms of small sample sizes and a lack of reliable and objective measures. The quality scores did not significantly moderate the relationships between different pro-environmental behaviours (B = 0.04, 95% CI = [-0.03, 0.11]). This could be due to the fact that most studies had similar quality scores, with many studies receiving an overall score of 3 (SD = 1) on a scale from 0 to 8 (higher numbers indicate higher quality). Only a few studies had substantially higher or lower quality scores, which may not have been sufficient to detect any moderating effects of study quality on the relationships between behaviours. This homogeneity in quality scores across studies suggests that variations in study

quality were not substantial enough to significantly influence the observed relationships among the different pro-environmental behaviours.

Discussion

We investigated the correlations between pro-environmental behaviours within and across different behavioural domains (e.g., water conservation, energy conservation, resource management). Identifying the patterns of associations between pro-environmental behaviours can potentially determine whether behaviours cluster within specific domains, such as energy conservation or resource management, or whether connections extend across domains, potentially reflecting shared motivators or underlying pro-environmental tendencies. This is important as it can inform the development of interventions designed to target multiple behaviours simultaneously, amplifying their overall environmental impact.

The findings reveal that pro-environmental behaviours are correlated, but this differs from one domain to another and is stronger for behaviours belonging to the same main domain. Significant correlations within-domains were only found for two domains (i.e., energy conservation and resource management), contrary to existing findings suggesting no relationships between resource management behaviours, such as reducing waste and recycling (e.g., Ebrero & Vining, 2001). Correlations between different pro-environmental domains were also identified. For example, energy conservation behaviours were positively associated with water conservation, resource management, and civic actions. Sustainable transportation was positively associated with energy conservation, water conservation, and resource management. Although these correlations are small, they suggest that individuals engage in multiple pro-environmental behaviours across different domains.

Although the strength of the relationships between behaviours varies across domains, the findings support the idea that pro-environmental behaviours may cluster together. While the present review did not apply formal clustering techniques, future research could explore this further to understand how PEBs group together. The review identified behavioural domains based on thematic similarity, but a data driven approach could reveal alternative groupings of behaviour.

The presence of positive correlations between pro-environmental behaviours may indicate an underlying pro-environmental factor, that would represent a general propensity to engage in pro-environmental behaviour. This could be considered similar to the concept of a p-factor in psychopathology, which represents a general psychopathology factor that captures a predisposition towards psychopathology (Caspi & Moffitt, 2018). In the context of pro-environmental behaviour, there may be an ‘E-factor’, which indicates a predisposition towards sustainability. Various pro-environmental behaviours are predicted by similar constructs. For example, nature connectedness has been found to predict engagement in various pro-

environmental behaviours (e.g., Teixeira et al., 2022). Studies have also investigated PEB as a multidimensional construct. For instance, research (e.g., Wong et al., 2025; Mateer et al., 2022) identified a two factor structure of pro-environmentalism representing public and private sphere behaviours. Future research should investigate the existence of the hypothesised E-factor, the shared variance across behaviours and the potential presence of a general pro-environmental tendency via factor analyses.

An important finding from the present review was that there were no negative correlations between pro-environmental behaviours, consistent with the hypothesis that engaging in one pro-environmental behaviour may either encourage additional pro-environmental behaviours or have no detrimental effect. It is important to note that these associations do not imply causation and may instead reflect an underlying general predisposition toward pro-environmentalism. Our finding aligns with the suggestion that negative spillover is less common in the context of environmental behaviour than positive spillover (Truelove & Nugent, 2020). However, most of the studies included relied on self-reported measures, which are susceptible to bias that can inflate observed associations due to common method variance. Maki et al. (2019) found small positive spillover effects on behavioural intentions, but negative and small effects on behaviour. That is, individuals who intend to engage in one pro-environmental behaviour may also intend to engage in others, but when actual behaviour was measured, this pattern could not be found. It is possible for negative spillover to be present in relationships where no reliable conclusions could be drawn due to small samples, weak methodological quality, and small numbers of effect sizes.

Demographic variables, including, type of sample, gender, and age, did not significantly moderate the relationships between pro-environmental behaviours. Previous research has found that demographic variables influence the likelihood of engaging in sustainable behaviours (Swenson & Wells, 2018; Brandenstein et al., 2023), such as people from more affluent backgrounds engage more in pro-environmental behaviours than people from less affluent backgrounds. While demographic variables may predict the likelihood of engaging in individual pro-environmental behaviours, they may not necessarily moderate the relationships between pro-environmental behaviours. Future research could explore whether other demographic variables, such as income and education level, might influence these relationships.

The current review identified a wide range of pro-environmental behaviours that studies investigated. Behaviours related to water and energy conservation were the most prevalent, while civic actions were the least prevalent. Our findings support the idea that the behaviours that are most investigated are not necessarily the same as the behaviours with the highest environmental impact. As highlighted by Wynes and Nicholas (2017), having one fewer child, living car free, avoiding flights, and adopting a plant-based diet are the most impactful behaviours from a greenhouse gas emissions perspective. The current systematic review showed different research priorities, as we have not identified any papers related to family planning, only two papers had a

measure of avoiding flights (Vieira et al. 2023; Burger et al., 2022), and the studies investigating sustainable food consumption opted for measuring reducing consumption of animal products rather than adopting a plant-based diet (e.g., Vieira et al., 2023). This highlights a significant research gap, as behaviours with substantial environmental impact are less frequently studied compared to more commonly studied but lower impact behaviours.

Although high-impact behaviours are essential for climate mitigation, the aim of the current review was to examine associations between behaviours based on thematic domains (e.g., energy conservation, water conservation) rather than an impact-based classification. This approach was chosen to investigate behaviours at both a broad level (between domains) and a specific level (within domains). Future research could explore alternative categorisations, such as those based on environmental impact, but as there are various metrics for establishing impact, such categorisations need to be informed by robust life-cycle analyses.

Strengths and limitations of the present review

The present study is the first systematic review to investigate the correlations between pro-environmental behaviours. The review identified a wide range of pro-environmental behaviours, which were categorised at two levels of specificity (e.g., broad domain - water conservation, specific domain - choosing water efficient appliances). This categorisation builds upon existing frameworks, such as those proposed by Wynes and Nicholas (2017) and Ivanova et al. (2020), which focused on categorising behaviours based on environmental impact. By incorporating a hierarchical approach that captures both broad and specific behavioural domains, the present framework offers a more detailed understanding of pro-environmental behaviours. Moreover, our findings have implications for theory and allow us to make recommendations for interventions. As correlations were observed both between behaviours that belong to the same main domain, but also between behaviours belonging to different domains, interventions could consider a dual approach, designing interventions that are domain specific but that can also target other domains. For instance, promoting energy conservation might also indirectly encourage water conservation and resource management, maximising the overall environmental impact of the intervention. Research needs to investigate whether effectiveness would be maximised by targeting multiple pro-environmental behaviours that are correlated rather than designing separate interventions for individual behaviours.

The strengths of the review include the thoroughness of the search that was carried out, which led to initial identification of 5,641 papers across three databases, and the additional search strategies included reference searches, and recommendations from experts. The review was conducted following established recommendations to ensure transparency and replicability. All the information regarding the search strategy, data extraction, and second coder agreement is provided in an online repository.

Despite the contributions of this review, several limitations should be acknowledged. First, the review identified a wide range of pro-environmental behaviours, but certain behaviours, such as civic actions, were underrepresented. Moreover, the six domains investigated did not cover all possible pro-environmental behaviours. As identified in previous literature (e.g., Wynes & Nicholas, 2017), other behaviours, such as family planning, also have a significant environmental impact. However, it was not possible to find any correlations for those behaviours, which could limit the generalisability of the findings across all domains of pro-environmental behaviour.

Second, it was not possible to analyse the correlations at a more specific level due to a low number of effect sizes. This would have allowed a thorough investigation of the pattern of specific behavioural correlations and whether these correlations are higher for behaviours that belong to the same domain than for behaviours belonging to different domains. Third, as the systematic review only focused on individual behaviour, studies that focused on groups of people belonging to larger entities (e.g., schools, companies, farms) were not included. This was because we focused one behaviours that individuals have personal control over, rather than those influenced or dictated by institutional policies or collective group dynamics. Future research could investigate the differences between individual and group pro-environmental behaviours. The search strategy represents another limitation, as it focused on identifying studies that investigated correlations between behaviours across different domains, possibly missing studies that only included correlations between behaviours belonging to the same domain. The limitation of the search strategy did not affect the ability to investigate within-domain relationships as a substantial number of within-domain correlations was still captured.

Ultimately, although we attempted to identify and correct for publication bias, most of the studies included were published in peer-reviewed journals. While the PET-PEESE method was applied to detect and adjust for publication bias, the results should be interpreted with caution as in many behavioural pairs the number of studies was small, which resulted in low degrees of freedom in the model (often below 4). Under these conditions, the PET model is underpowered and may fail to detect existing bias, while the PEESE is known to overcorrect in small samples or when there is high heterogeneity (Stanley & Doucouliagos, 2013). In some cases, the corrected estimates were substantially different from the original effect size detected in the meta-analysis, but these differences often coincided with low degrees of freedom. Moreover, publication bias may be less plausible in this context as the relationships between specific behavioural pairs were rarely the primary focus of the studies included.

Weaknesses of the evidence base

The investigation of the methodological quality of the studies revealed weaknesses of pro-environmental behaviour research. While the review found that the quality of studies did not moderate the relationships between behaviours, the overall methodological quality of the included

studies was relatively low, often characterised by small sample sizes and a lack of objective and reliable measures. Self-report measures were prevalent, which are often criticised due to the potential biases associated with them (e.g., social desirability) and the lack of validity. Lange and Dewitte (2019) argue that self-report measures reflect individuals' propensity to engage in pro-environmental behaviours rather than engagement itself, as individuals cannot reliably recall their sustainable practices. Future research should aim to incorporate more objective measures of behaviour and more diverse samples to improve the robustness of the findings.

Conclusions

This systematic review identifies a range of behaviours contained within six general domains of pro-environmental behaviour, and highlights several positive correlations across and within domains. The lack of observed negative correlations provides reassurance that concerns about negative spillover may be less warranted. The findings suggest the possibility of an underlying pro-environmental factor, underscoring the potential for interventions that target multiple behaviours to amplify environmental impact. While the review made significant progress in mapping the relationships between pro-environmental behaviours, further research is needed to address the existence of the underlying factor, and the potential of behaviour clusters and core behaviours. The review also highlights the importance of viewing pro-environmental behaviours as interconnected, taking more holistic perspectives when investigating underlying factors and intervention development.

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*identified through systematic review and included in the meta-analyses

Supplementary Materials

Contents:

Appendix A: Detailed search strategy

Scopus - 5065 records identified

(((TITLE-ABS-KEY ("sustainable transport*" OR "eco-friendly transport*" OR "reduce car" OR "lower car" OR "active transport*" OR "sustainable travel*" OR "sustainable mode* of transport*" OR "electric vehicles" OR "public transport*" OR "carpooling" OR "reduce flight*" OR "reduce air travel" OR "air travel" OR "flights")) AND ((TITLE-ABS-KEY ("Meat consumption" OR "vegetarian*" OR "vegan*" OR "meat intake" OR "meat" OR "dairy" OR "sustainable food*" OR "ecological food*" OR "flexitarian*")) OR (TITLE-ABS-KEY ("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy")) OR (TITLE-ABS-KEY ("Water conservation" OR "sav* water" OR "water efficiency")) OR (TITLE-ABS-KEY ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR " plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*")) OR (TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) OR (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*")))) OR ((TITLE-ABS-KEY ("Meat consumption" OR "vegetarian*" OR "vegan*" OR "meat intake" OR "meat" OR "dairy" OR "sustainable food*" OR "ecological food*" OR "flexitarian*")) AND ((TITLE-ABS-KEY ("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy")) OR (TITLE-ABS-KEY ("Water conservation" OR "sav* water" OR "water efficiency")) OR (TITLE-ABS-KEY ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR " plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*")) OR (TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) OR (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*")))) OR ((TITLE-ABS-KEY ("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy")) AND ((TITLE-ABS-KEY ("Water conservation" OR "sav* water" OR "water efficiency")) OR (TITLE-ABS-KEY ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR " plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*")) OR (TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) OR (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*")))) OR ((TITLE-ABS-KEY ("Water conservation" OR "sav* water" OR "water efficiency")) AND ((TITLE-ABS-KEY ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR " plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*")) OR (TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) OR (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations"

OR "sustainab* campaign*")))) OR ((TITLE-ABS-KEY ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR " plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*")) AND ((TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) OR (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*")))) OR ((TITLE-ABS-KEY ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood")) AND (TITLE-ABS-KEY ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*")))) AND (TITLE-ABS-KEY ("participant*" OR "human*" OR "responde*" OR "adult*" OR "adolescent*" OR "student*" OR "general population"))

GreenFILE - 452 records identified
1 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND (("sustainable transport*" OR "eco-friendly transport*" OR "reduce car" OR "lower car" OR "active transport*" OR "sustainable travel*" OR "sustainable mode* of transport*" OR "electric vehicles" OR "public transport*" OR "carpooling" OR "reduce flight*" OR "reduce air travel" OR "air travel" OR "flights") AND (("Meat consumption" OR "vegetarian*" OR "vegan*" OR "meat intake" OR "meat" OR "dairy" OR "sustainable food*" OR "ecological food*" OR "flexitarian*") OR ("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy") OR ("Water conservation" OR "sav* water" OR "water efficiency") OR ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR" plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*") OR ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") OR ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*"))) 62
2 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND (("Meat consumption" OR "vegetarian*" OR "vegan*" OR "meat intake" OR "meat" OR "dairy" OR "sustainable food*" OR "ecological food*" OR "flexitarian*") AND (("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy") OR ("Water conservation" OR "sav* water" OR "water efficiency") OR ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR" plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*") OR ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") OR ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*"))) 84

3 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND (("Energy conserv*" OR "energy saving" OR "saving energy" OR "green energy") AND (("Water conservation" OR "sav* water" OR "water efficiency") OR ("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR" plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*") OR ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") OR ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*"))) 120
4 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND (("Water conservation" OR "sav* water" OR "water efficiency") AND (("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR" plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*") OR ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") OR ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*"))) 111
5 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND (("Reuse plastic" OR "recycle plastic" OR "reduce plastic" OR" plastic alternative" OR "plastic prevent∗" OR "plastic substitute∗" OR "bioplastic" OR "plastic" OR "resource* manage*") AND (("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") OR ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*"))) 80
6 (“participant*” OR “human*” OR “responde*” OR “adult*” OR “adolescent*” OR “student*” OR “general population”) AND ("Reduce child*" OR "family plan*" OR "population control" OR "planned parenthood") AND ("environmental education" OR "education for sustainability" OR "sustainab* education" OR "eco-activism" OR "sustainab* activism" OR "sustainab* donations" OR "sustainab* campaign*") 4
7 (1 or 2 or 3 or 4 or 5 or 6 or 7) 452

PsycInfo - 124 records identified

1 ("sustainable transport*" or "eco-friendly transport*" or "reduce car" or "lower car" or "active transport*" or "sustainable travel*" or "sustainable mode* of transport*" or "electric vehicles" or "public transport*" or "carpooling" or "reduce flight*" or "reduce air travel" or "air travel" or "flights").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] 4572

2 ("Meat consumption" or "vegetarian*" or "vegan*" or "meat intake" or "meat" or "dairy" or "sustainable food*" or "ecological food*" or "flexitarian*").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] 5271
3 ("Energy conserv*" or "energy saving" or "saving energy" or "green energy").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]969
4 ("Water conservation" or "sav* water" or "water efficiency").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] 207
5 ("Reuse plastic" or "recycle plastic" or "reduce plastic" or " plastic alternative" or "plastic prevent∗" or "plastic substitute∗" or "bioplastic" or "plastic" or "resource* manage*").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]23381
6 ("Reduce child*" or "family plan*" or "population control" or "planned parenthood").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]6980
7 ("environmental education" or "education for sustainability" or "sustainab* education" or "eco-activism" or "sustainab* activism" or "sustainab* donations" or "sustainab* campaign*").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] 2770
8 ("participant*" or "human*" or "responde*" or "adult*" or "adolescent*" or "student*" or "general population").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] 3188358
9 exp Experimental Subjects/ 4902
10 8 or 9 3189188
11 1 and (2 or 3 or 4 or 5 or 6 or 7) 57
12 2 and (3 or 4 or 5 or 6 or 7) 41
13 3 and (4 or 5 or 6 or 7) 39
14 4 and (5 or 6 or 7) 22
15 5 and (6 or 7) 32
16 6 and 72
17 11 or 12 or 13 or 14 or 15 or 16 189
18 10 and 17 124

Appendix B: Data coding framework

Data item	Definition of data item	Coding*
A. STUDY DETAILS		
Paper ID	Unique ID for each paper	Numerical entry
Study ID	Unique ID for each study	Numerical entry
Sample ID	Unique ID for each sample used within a study	Numerical entry
Effect size ID	Unique ID for each one of the effect sizes calculated	Numerical entry
Authors	The names of the authors	Text entry
Year	The year the paper was published	Numerical entry
Study country	The country where the study was conducted	Text entry (separated by comma if multiple countries are involved)
Design	The design of the study	Text entry coded subsequently as: 1 = Experimental 2 = Quasi-experimental 3 = Case study 4 = Observational 5 = Longitudinal
B. SAMPLE		
Type of sample	The classification of the sample used in the study, such as population group (e.g., adults)	Text entry coded subsequently as: 1 = General population 2 = Households 3 = University students 4 = Young adults 5 = School students 6 = Children (<14)

Sample size	The total number of participants	Numerical entry
Age	The age range of the study participants and/or the mean age if specified. Include specific details if the study provides separate ranges for different groups or conditions.	Numerical entry. Subsequently recorded only the mean for analysis.
Gender	The sex distribution within the sample. Specify if the study includes only one gender or a mix, and the numbers or proportions if reported.	Text and numerical entry (e.g., 20 males, 50 females). If proportions are provided, record as a percentage. Subsequently recorded only the percentage of females in the sample for analysis.
Country of participants	The country where the participants are recruited from.	Text entry coded subsequently as: 1 = Germany 2 = USA 3 = Denmark 4 = Italy 5 = Portugal 6 = Spain 7 = Malaysia 8 = China 9 = Lithuania 10 = UK 11 = Finland 12 = Australia
C. BEHAVIOUR		
PEB 1	Pro-environmental behaviour reported in the study	Text entry

PEB 2	Pro-environmental behaviour reported in the study	Text entry
PEB category 1	The broader category of pro-environmental behaviour PEB 1 belongs to	Text entry coded subsequently as: 1 = Transportation behaviour 2 = Eating behaviour 3 = Energy conservation 4 = Water conservation 5 = Resource management 6 = Civic actions 7 = Family planning
PEB category 2	The broader category of pro-environmental behaviour PEB 2 belongs to	Text entry (as above)
Subdomain PEB 1	The specific category of pro-environmental behaviour PEB 1 belongs to	Text entry coded subsequently as: 1 = Flying 2 = Using public transport 3 = Active travel 4 = Car 5 = Animal products 6 = Sustainable food purchase 7 = Managing food waste 8 = Choosing electricity-efficient appliances 9 = Sustainable use of energy appliances/devices 10 = Monitor electricity consumption 11 = Renewable energy 12 = Reducing energy use 13 = Choosing water efficient appliances 14 = Sustainable use of water appliances 15 = Reducing water use 16 = Efficient irrigation

		17 = Green purchasing 18 = Recycling 19 = Reducing 20 = Reusing 21 = Composting 22 = Not littering 23 = Communication/information 24 = Donation 25 = Active participation
Subdomain PEB 2	The specific category of pro-environmental behaviour PEB 2 belongs to	Text entry coded subsequently as: 1 = Flying 2 = Using public transport 3 = Active travel 4 = Car 5 = Animal products 6 = Sustainable purchase 7 = Managing food waste 8 = Choosing electricity-efficient appliances 9 = Sustainable use of energy appliances/devices 10 = Monitor electricity consumption 11 = Renewable energy 12 = Reducing energy use 13 = Choosing water efficient appliances 14 = Sustainable use of water appliances 15 = Reducing water use 16 = Efficient irrigation 17 = Green purchasing 18 = Recycling 19 = Reducing 20 = Reusing 21 = Composting 22 = Not littering 23 = Communication/information 24 = Donation

		25 = Active participation
Within/between	Specifies if PEB 1 and PEB 2 belong to the same PEB category (i.e., PEB 1 ≡ PEB 2) or to different PEB categories, so the correlation conducted between the two PEBs is within category in the former and between categories in the latter.	Text entry coded subsequently as: 1 = Within 2 = Between
Property of PEB 1	The measurable property of the behaviour investigated	Text entry coded subsequently as: 1 = Occurrence (binary outcome) 2 = Frequency 3 = Intensity 4 = Duration
Property of PEB 2	The measurable property of the behaviour investigated	Text entry coded subsequently as: 1 = Occurrence (binary outcome) 2 = Frequency 3 = Intensity 4 = Duration
(Mis)Matched property (1/0)	Assess if property of PEB1 and property of PEB2 are the same or distinct.	Coded subsequently as: 0 = Property of PEB1 is not the same as property of PEB2 1 = Property of PEB1 is the same as property of PEB2
Matched property	If property of PEB1 is the same as property of PEB2, then this shows which behaviour they both represent.	Coded subsequently as: 0 = Property of PEB1 is not the same as property of PEB2 1 = Property of PEB1 and PEB2 is occurrence. 2 = Property of PEB1 and PEB2 is frequency. 3 = Property of PEB1 and PEB2 is intensity.

		4 = Property of PEB1 and PEB2 is duration.
Motive inference PEB 1	Level of inference with respect to PEB 1 being driven by a pro-environmental motive	Text entry coded subsequently as: 1 = Other reasons (Likely done for other reasons but has incidental environmental benefits) 2 = Possibly environmental (Possibly done for environmental reasons) 3 = Primarily environmental (Primarily done for environmental reasons)
Motive inference PEB 2	Level of inference with respect to PEB 2 being driven by a pro-environmental motive	Text entry coded subsequently as above
(Mis)Matched inference (1/0)	Assess if motive inference PEB1 and motive inference PEB2 are the same or distinct.	Coded subsequently as: 0 = Motive inference PEB1 is not the same as motive inference PEB2 1 = Motive inference PEB1 is the same as motive inference PEB2
Matched inference	If motive inference PEB1 is the same as motive inference PEB2, then this shows which motive they both represent.	Coded subsequently as: 0 = Motive inference PEB1 is not the same as motive inference PEB2. 1 = Both PEB1 and PEB2 have been likely done for other reasons. 2 = Both PEB1 and PEB2 have been possibly done for environmental reasons. 3 = Both PEB1 and PEB2 are primarily done for environmental reasons.
Measure type 1	Describes the general format or structure of the measurement tool used to assess PEB 1	Text entry coded subsequently as: 1 = Self-report 2 = Behavioural

		3 = Outcome
Measure type 2	Describes the general format of the measurement tool used to assess PEB 2	Text entry coded subsequently as: 1 = Self-report 2 = Behavioural 3 = Outcome
Measure PEB 1	Describes the structure of the measurement tool used to assess PEB 1	Text entry coded subsequently as: 1 = Single item 2 = Multi-item
Measure PEB 2	Describes the structure of the measurement tool used to assess PEB 2	Text entry coded subsequently as: 1 = Single item 2 = Multi-item
Specific measure	Details the exact measurement tool or item used to assess the behaviour. This can include the name of a standardised scale or the wording of a specific item	Text entry. For standardised scales, record the name of the scale (e.g., "General Ecological Behavior Scale"). For specific items, quote the item directly (e.g., "I recycle often")
D. STATISTICS		
Effect size reported	Indicates whether the study reports an effect size for the relationship investigated	Text entry Subsequently coded as: 0 = No 1 = Yes
Effect size initial	Identifies the specific type and value of the effect size reported in the study.	Text entry. Record the effect size as reported by the study (Pearson's r is used as standard; specify if other effect sizes are used)
Effect size (r)	Records the converted effect size value in Pearson's r	Numerical entry

Effect size (z)	Indicates that the reported effect size has been converted into a common metric for analysis purposes. This conversion aims to standardise effect sizes for meta-analysis.	Numerical entry converted using Excel formula=FISHER
Reliability	Refers to the consistency of the scale across time, different items, and various conditions	Text entry coded subsequently as: 0 = Not reported 1 = Unacceptable (e.g., Cronbach's alpha: 0.01 - 0.60) 2 = Questionable (e.g., Cronbach's alpha: 0.61 - 0.70) 3 = Acceptable (e.g., Cronbach's alpha: 0.71 - 0.80). 4 = Good (e.g., Cronbach's alpha: 0.81 - 0.90) 5 = Excellent (e.g., Cronbach's alpha ≥ 0.9)
Variance	Measure of variability needed for meta-analysis	Numerical entry converted using Excel formula 1/(N-3)

*leave blank if not mentioned, unless specified otherwise by the coding framework

Appendix C: Studies included and behaviours measured in each

This table displays the behaviours that the included studies measured, and how the correlations between behaviours were obtained (e.g., retrieved from the papers, sent via email by authors, calculated from raw data).

Study ID	Author and date	Behaviours	Where to find correlations
3	Burger et al. (2022)	1. Using tumble dryer* 2. Talking about energy saving with other people 3. Separate trash 4. Not taking private plane trip 5. Avoiding eating meat 6. Buying items in refillable packs 7. Undertaking structural measures to save energy (e.g., facade insulation) 8. Throwing empty batteries in the bin*	Open access data
19 (3 studies)	Ballew (2018)	1. Energy conservation 2. Water conservation 3. Donation to an environmental organization	Table E3
33	Thøgersen (2006)	Buying organic milk, Taking the bus or train to work, Taking the bus or train when shopping, Buying energy saving light bulbs, Composting green kitchen waste in the garden or at a municipal facility	Correlation matrix sent via email
39	Castellini et al. (2023)	Sustainable food consumption, energy, green purchasing, recycling, mobility	Figure 1
51	Vieira et al. (2023)	6 domains: 1. Using public transport 2. Walking and cycling instead of driving 3. Avoiding long-distance flights 4. Choosing train/bus/boat instead of flying 5. Reduce consumption of meat 6. Reduce consumption of eggs and dairy 7. Reduce consumption of fish 8. Turning off lights when leaving the room	Open access data

		9. Cutting down on heating or air conditioning to limit energy use 10. Turning off the TV when leaving the room 11. Reducing domestic energy consumption 12. Limiting time in the shower in order to conserve water 13. Waiting until having a full load to use the washing machine or dishwasher 14. Closing the tap while brushing teeth 15. Reducing waste 16. Separating various types of garbage for recycling 17. Cutting down on consumption of disposable items 18. Reusing food leftovers 19. Buying local products	
83	Sanguinetti et al. (2022)	75 water/energy saving measures, grouped into 8 categories after FA: 1. Advanced efficiency 2. Efficient appliance 3. Maintenance and management 4. Energy conservation 5. Water conservation 6. Efficient irrigation 7. Green gardening 8. Green landscaping	Table 5 (table 3 explains what each domain includes)
84	Ibáñez-Rueda et al. (2021)	5 water-saving behaviours: 1. 'Do you collect the water in the shower while you wait for it to come out hot (put a bucket in the shower to catch the cold water that comes out first)?'(shower) 2. 'do you defrost your food in advance to avoid defrosting it under the tap?' (food treatment) 3. 'do you wait until the dishwasher and washing machine are full to run them?' (appliances),	Data sent via mail

		4. ‘do you close the stopcock a little to reduce the flow rate of the taps?’ (use of taps) 5. ‘do you turn off the tap while brushing your teeth?’ (dental hygiene).	
100	Ilham et al. (2022)	11 energy conservation practices: P01: Turn off the lights when not in use. PO2: Turn off the fan where there is nobody in the room. P03: Buy things that are likely to reduce energy consumption or resource use. P04: Will pay more for environmentally friendly products. P05: Avoid charging mobile phones/ laptop Overnight P06: Avoid using mobile phones/ laptop while charging. P07: Leave electronic devices on standby mode.* P08: Use rechargeable batteries. P09: Leave the plug of an electronic device plugged in when not in use.* P10: Leave television/computer on when not in use* P11: Switch on the light during daytime.*	Correlation matrix sent via email
113	Jia and Yu (2021)	Original scale in Mandarin*: 1. Participating in activities related to environmental protection 2. Collecting and recycling used plastic containers 3. Keeping the air-conditioning running in the summer all day* 4. Reusing a blank paper to write 5. Keeping the air purification system running* 6. Keeping the heat on in the winter* 7. Taking garbage when leaving public places and throwing it in the trash	Open access data

		8. Buying products made from recyclables 9. Putting dead batteries in the garbage* 10. Minimising the use of plastic tableware 11. Reusing shopping bags 12. Turning off air conditioner and air purifiers when going out 13. Not travelling by public transport* 14. Throwing some small pieces of garbage on the street* 15. Keeping water running when washing dishes* 16. Taking plastic bag in store when offered 17. Using rechargeable batteries. 18. Turning off TV and computer screens when not in use 19. Keeping water running while brushing teeth* 20. Collecting and paying attention to news related to the environment 21. Not littering outside, but throwing it in the trash 22. Turning off lights when not needed 23. Using energy efficient light bulbs (all x2 - parents + children)	
126	Poškus (2020)	Recycling, water, electricity, transportation	Correlation matrix sent via email
154	Smith et al. (2019)	1. Red and processed meat consumption* 2. Active travel	Table 4
177	Bartolotta and Hardy (2018)	1. Using reusable bag 2. Drinking bottled water at home* 3. Drinking bottled water when away* 4. Sustainable disposal of plastic bags 5. Sustainable disposal of plastic bottles	Data sent via email
210	Petersen et al. (2016)	1. Reducing electricity 2. Reducing water use	Open access data

219	Segev (2015)	Recycling (3 items), water conservation (4 items), electricity efficient appliances (3 items), electricity routine behaviours (3 items), energy conservation (4 items)	Open access data (+ table 1 has correlations)
226	Korkola et al. (2014)	"What have you done in order to mitigate the possible climate change?" 1. Recycling 2. Consuming less and producing less trash 3. Consuming more ecologically 4. Composting biodegradable water 5. Using eco-friendly products 6. Cutting down motoring 7. Preferred public transport 8. Purchasing less fuel consuming car 9. Giving up motoring 10. Avoiding flying 11. Conserving energy 12. Using renewable energy sources for heating 13. Monitoring electricity consumption of home appliances 14. Switching to less electricity consuming appliances 15. Demanding action from policymakers and authorities 16. Participating actively in civic organizations	Table S2 in supplementary materials
230	Martínez-Espiñeira et al. (2014)	1. Filling the sink before washing the dishes 2. Filling the washing machine and the dishwasher before using them 3. Separating organic waste 4. Double-glazed windows installed 5. Owning a water and energy efficient washing machine 6. Owning an energy-efficient fridge	Table 4
256	Fielding et al. (2010)	1. Taps - Check and fix leaking taps. 2. Dishes - Only run the dishwasher when full.	Sent a correlation matrix via email

		3. showers - Have shorter showers. 4. flush - Use half flush or don't flush every time. 5. washcar - Wash car with minimal water. 6. brushteeth - Turn off the tap while brushing teeth. 7. fullload - Only run the washing machine with full loads. 8. greywater - Using greywater on the garden. 9. waterwise - Be water-wise in the garden. 10. switchoff - Switch off unused appliances at power point. 11. lights - Switch off unused lights. 12. coldwash - Using cold water in washing machines. 13. linedry - Dry clothes on the line rather than in the dryer. 14. electronics - Switch computers and electronics off when not in use. 15. aircon - Run air conditioners at an efficient temperature. 16. winclosed - Keeping doors and windows closed when using air-conditioners. 17. curtains - Close curtains on hot summer days and cold winter nights. 18. ownbags - Using own bag when shopping. 19. lesspack- Choose products with less packaging. 20. recpack - Choose products with recyclable/reusable packing, 21. buybulk - Reducing packaging by buying in bulk. 22. concentrate - Buy concentrated products.	

		23. disposable - Avoid disposable products. 24. noplasticbags - Do not use unnecessary plastic bags or packaging. 25. reusabags - Reusing plastic bags. 26. dontneed - Buying goods that are not needed.* 27. lowflow - Install low-flow taps and showerheads. 28. poolcover - Install a pool cover. 29. trigger - Install a hose with trigger or timed water system. 30. dishwasher - Install a water-efficient dishwasher. 31. washer - Install a water-efficient washing machine. 32. tank - Install a rainwater tank. 33. greywatersystem - Install a greywater system. 34. toilet - Install a dual-flush or composting toilet. 35. timer - Install a shower timer. 36. solarhot - Install solar hot water. 37. solarpanel - Install solar panels. 38. fluoro - Install fluorescent lighting. 39. insulation - Install household insulation. 40. electronic - Install electronic equipment with energy star rating. 41. whitegoods - Install white goods and appliances with four star Australian energy ratings or above.	
ES1	Stangherlin et al. (2023)	1. Recycled glass and papers 2. Sorting green kitchen waste for composting 3. Bought products from recycled materials 4. Bought used products 5. Chose recycled packaging In 2 countries - 20 correlations.	Table S3 in Supplementary Materials

ES2	Jamaludin et al. (2022)	1. Turn off the lights when not in use. 2. Turn off the fan where there is nobody in the room. 3. Buy things that are likely to reduce energy consumption or resource use. 4. Will pay more for environmentally friendly products. 5. Avoid charging mobile phones/laptop overnight. 6. Avoid using mobile phones/laptop while charging. 7. Leave electronic devices on standby mode. 8. Leave the plug of an electronic device plugged in when not in use. 9. Leave television/computer on when not in use. 10. Switch on the light during daytime.	Correlation table sent via email
M1	Carrico et al. (2018)	Making a donation to an environmental cause and meat consumption (2 groups)	Maki (2019) - effect size reported
M2	Geng et al. (2016)	Green purchases and water conservation	Maki (2019) - effect size reported
M3	Maki (2015)	Paper recycling and other recycling	Maki (2019) - effect size reported
M4	Poortinga et al. (2013)	1. Using own bag in store 2. Buying energy-saving light bulbs 3. Recycling household waste (2 samples)	Maki (2019) - effect size reported
M5	Schultz et al. (2015)	Purchasing certified LED lighting in their homes and electricity consumption	Maki (2019) - effect size reported
M6	Thomas et al. (2016)	1. Using own bag in store 2. Energy conservation 3. Water conservation 4. Green purchases 5. Transportation	Maki (2019) - effect size reported
M7	Tiefenbeck et al. (2013)	Water conservation and energy conservation	Maki (2019) - effect size reported