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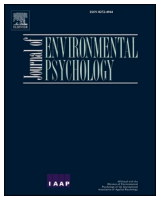

# The psychological benefits of open-water (wild) swimming: Exploring a self-determination approach using a 19-country sample

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ABSTRACT

A growing body of qualitative and quantitative research has explored the potential benefits to mental health and well-being of open-water or "wild" swimming. To date, most studies have used small samples in specific locations, limiting generalisability, and have not distinguished open-water swimming from other forms of outdoor swimming, such as in open-air pools, raising questions about any additional benefits of wild swimming over and above swimming outside *per se*. Using survey data from n = 1200 recently recalled outdoor swimming visits across 19 different countries, we compared self-reported well-being outcomes for swims in either open-water (wild) locations or open-air pools. Additionally, we explored the degree to which satisfaction of the motivations identified by self-determination theory (i.e. autonomy, relatedness, and competence) may explain any differences. Swimming visits in both locations were associated with high levels of positive, and low levels of negative, well-being, as well as high levels of autonomy, relatedness and competence. Open-water swimming was, nonetheless, associated with significantly higher positive well-being than open-air pool swims, with mediation analysis indicating that feelings of greater autonomy and competence (but not relatedness) primarily accounted for the difference. Results for anxiety were more nuanced, perhaps because more competent swimmers were more likely to swim in less safe, more anxiety inducing, places. Results re-iterate, help explain, and support the generalisation of previous research reporting potential benefits of open-water swimming for mental health and well-being, and highlight the need to support further safe access to high quality open-water locations.

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## 1. Introduction

### 1.1. Blue spaces, health, and well-being

A growing body of work has highlighted the positive effects of nature exposure on human health and well-being (for reviews and meta-analyses see e.g. Bratman et al., 2019; Gascon et al., 2016; Lackey et al., 2021; Rojas-Rueda et al., 2019; Tillmann et al., 2018; Twohig-Bennett & Jones, 2018; van den Berg et al., 2015; van den Bosch & Ode Sang, 2017; Yang et al., 2021). However, much of this research has focused either exclusively on green spaces (e.g., forests, parks, and grassland), or natural environments in general, with far less research exploring the salutogenic role of blue spaces (e.g., rivers, lakes, and coastal areas, Grellier et al., 2017). While green and blue spaces likely provide some similar benefits, blue spaces are increasingly recognised as distinct environments (Völker & Kistemann, 2015; White et al., 2010) with their own risks and benefits to health and well-being (Gascon et al., 2017; Georgiou et al., 2021; Smith et al., 2021; Völker & Kistemann, 2011; White et al., 2020).

To date, much scientific research has focused on the risks of blue spaces to health and well-being including drowning, heavy metal and microbial pollution, vector-borne diseases, harmful algal blooms, and antimicrobial resistance (Fleming et al., 2019). However, over the last decade there has been a revival of interest in the health promotion and disease prevention possibilities of blue spaces (Wheeler et al., 2014, chp 1; White et al., 2020). This shift in focus follows a long history of people engaging with blue spaces for health benefits, including practices such as sea bathing. In the UK, for instance, Dr Richard Russell's 1760 (Russell, 1760) book on sea bathing and health led to the construction and use of several sea-bathing hospitals around the country (Fortescue & Lloyd, 1938), which only fell out of favour after the invention of antibiotics and modern medicine (Wheeler et al., 2014, chp 1). On mainland Europe, "Thalassotherapy" (seawater therapy) continues to be prescribed as part of a range of health promotion programmes (Charlier & Chaineux, 2009), but is hardly seen as mainstream, in part due to uncertainty about the evidence of benefits.

Although evidence on the effects of blue space on physical health is inconsistent (Gascon et al., 2017; Georgiou et al., 2021; Smith et al., 2021), a recent cross-sectional study (using a Bayesian approach) in 15 countries found links between coastal proximity and coastal visits and self-reported general health (Geiger et al., 2023). Results on mental health benefits and well-being are also fairly consistent (Gascon et al., 2017), with more recent studies further supporting this notion (de Vries et al., 2021). For instance, prescription rates of antidepressant medication among older adults in Scotland were lower in areas with greater blue space availability (McDougall et al., 2021).

While not all studies have found residential exposure to blue spaces to be related to better mental health (e.g. Gascon et al., 2018), actively and deliberatively engaging with blue spaces appears to be a stronger predictor of psychological outcomes (mental health, well-being) than whether or not one lives near blue spaces (Geiger et al., 2023; McDougall et al., 2022b; White et al., 2021). In part this seems to be due to the fact that living near water is associated with more frequent physical activity (Gascon et al., 2017; White et al., 2014), including "blue exercise" (e.g. swimming, watersports etc., White et al., 2016a). Indeed, some types of physical activity have been shown to mediate associations between coastal proximity and mental health (Pasanen et al., 2019). Accordingly, there is increasing interest in using blue space activity interventions to improve health and well-being (Britton et al., 2020; Foley et al., 2019, pp. 190–204; White et al., 2016b).

### 1.2. Open-water swimming

The health and well-being benefits of open-water swimming have gained increasing research attention in recent years. Open-water swimming, also referred to as "outdoor" or "wild" swimming, most commonly refers to swimming activities which take place in rivers, lakes, and seas (Atkinson, 2019; Foley, 2015; Olive & Wheaton, 2021; Overbury et al., 2023). Open-water swimming poses additional hazards, including currents, water quality, and temperature (Chamberlain et al., 2019; Evers & Phoenix, 2022; Tipton et al., 2017), compared to swimming in more controlled settings (such as indoor or open-air pools). However, many open-water swimmers are aware of these concerns and typically take measures to decrease personal risks (Costello et al., 2019; McDougall et al., 2022a; Oliver et al., 2023; Wood et al., 2022).

Open-water swimmers often perceive their swimming locations as more natural, healthier, and more calming than constructed settings (Foley, 2017). Some studies, particularly focused on swimming in colder waters have identified potential health benefits through pain relief (e.g. Bleakley et al., 2012), reduced inflammation and boosted immune function (Cain et al., 2025; Tipton et al., 2017) and lower levels of depression, anxiety, and stress (Mullooly & Colbert, 2024).

Open-water swimmers primarily cite perceived mental health benefits as their reason for continuing swimming in nature (Elliott et al., 2018; Oliver et al., 2023; Wood et al., 2022). For instance, while only 14% of participants in a cross-sectional study by Massey et al. (2022), stated improving well-being as their original motivation to start open-water swimming, most participants with mental health issues did report a perceived reduction in symptoms up to two days following swimming. This is also supported by diverse qualitative studies, where improved mood, increased capacities to deal with stress and adverse life events, and reduced poor mental health symptoms are often stated as benefits of open-water swimming by the swimmers themselves (Britton & Foley, 2021; Burlingham et al., 2022; Costello et al., 2019; McDougall et al., 2022a; Murray & Fox, 2021).

In a particularly innovative study, Massey et al. (2020) compared mood and well-being among novice open-water swimmers relative to their friends and family members who watched swims from the beach. They found stronger improvements in mood and well-being following each swimming session and over the course of the program among the open-water swimmers compared to the spectators (friends and family members). Similarly, Burlingham et al. (2022) found a decrease in depression and anxiety symptoms following group swimming sessions in the sea with some effects remaining even after three months. The cumulative benefits of repeated open-water swims are referred to by Foley as an "*accretive practice*" (Foley, 2017). Although most research to date has been conducted in European settings, a recent cross-sectional study in Indonesia similarly found that those who swam or snorkelled at least 1−3 days a week during the peak of the stressful COVID-19 pandemic lockdown period maintained higher levels of well-being than those who did not (Maharja et al., 2023).

To date, most open-water swimming studies have used relatively small sample sizes, and the few quantitative studies conducted have not been able to adequately control for other factors and potential confounders (i.e. factors that influence both the likelihood of going open-water swimming and well-being more generally such as age, income, and baseline levels of well-being; Overbury et al., 2023). Further, the reasons why open-water swimming might be particularly beneficial for mental health have received relatively little attention in terms of well-established theoretical models of psychological well-being. One exception is Thompson and Wilkie (2021), who argued that self-determination theory (SDT; Ryan & Deci, 2000) may be a useful framework for understanding the benefits of blue exercise more generally.

### 1.3. Self-determination theory and blue exercise

Self-determination theory (SDT; Ryan & Deci, 2000, 2022) postulates three basic psychological needs that need to be satisfied for someone to experience high levels of psychological well-being: *autonomy* (being free to make one's own choices), *relatedness* (feeling connected to others and part of something bigger than the self) and

*competence* (feeling skilled at something). These three psychological needs have been shown to be important in other sport and exercise contexts, including team sports (Amorose & Anderson-Butcher, 2007), endurance sports such as running (Doğusan & Koçak, 2024; Teixeira et al., 2012) and even physical education (Vasconcellos et al., 2020). These studies highlight that higher levels of autonomy, competence, and relatedness are associated with greater motivation, enjoyment, and long-term participation, suggesting that similar mechanisms may contribute to the psychological benefits of open-water swimming. Although few open-water swimming studies reference the theory directly, they often highlight one or more aspects of the open-water experience in ways that have parallels to the three postulated psychological needs.

#### 1.3.1. Autonomy

A sense of freedom has been highlighted as an important aspect of open-water swimming by both swimming instructors (Lloret et al., 2023) and swimmers themselves (Wood et al., 2022). In particular, the lack of formalised rules can allow swimmers more freedom in their choices of where exactly to swim, at what speed, and in what manner, which remains important even when swimming with others (Denton & Aranda, 2020). Open-water swimming is also associated with some degree of feeling out of control, as conditions in open-water can change quickly (Denton & Aranda, 2020). While some swimmers appreciated this feeling, for others, letting go can be difficult (Britton & Foley, 2021). Feelings of control can also vary in different open-water swimming environments, with lake swimming generally feeling safer and more controllable than sea swimming (McDougall et al., 2022a).

#### 1.3.2. Relatedness

Most accounts of why open-water swimming may be beneficial for well-being included some mention of concepts close to relatedness (Overbury et al., 2023). Wood et al. (2022) found that only one in five open-water swimmers reported swimming alone and over half of them gave socialising and a sense of community as important motivations for swimming (Overbury et al., 2023). Adults in England were almost three times as likely to report social motivations for coastal wild swimming compared with other types of coastal visit (Elliott et al., 2018). Being part of a community was reported as important both in formal (Burlingham et al., 2022; Lloret et al., 2023) and informal settings (Costello et al., 2019; Murray & Fox, 2021), and even for participants swimming alone, sharing the experience afterwards with others was still important (Denton & Aranda, 2020; McDougall et al., 2022a). Mentoring and social support networks that extended beyond the swim itself, may be particularly important for older open-water swimmers (Costello et al., 2019).

#### 1.3.3. Competence

Feelings of competence were also frequently mentioned in qualitative studies. Open-water swimmers explained that facing the challenges and risks associated with swimming in open-water and moving beyond their comfort zone allowed them to gain new skills, thereby boosting their confidence and feelings of self-efficacy (Britton & Foley, 2021; Burlingham et al., 2022; Costello et al., 2019; Denton & Aranda, 2020). Some also mentioned feeling more able to deal with the challenges of daily life because of these experiences (Murray & Fox, 2021; Wood et al., 2022).

### 1.4. Gaps in the literature and current research

Despite these investigations there has been little research which compares how swimming in different types of environments might differentially affect mental health. While physical activity in natural settings might be more beneficial to human well-being than physical activity in built environments (Wicks et al., 2022; Pasanen et al., 2014), some benefits of open-water swimming are likely to also be due to the activity itself, irrespective of the environment. For example, in the study by Massey et al. (2020), pool training sessions also had an acute positive effect on the mood of the swimmers. Additionally, many human-made pools are indoors which creates an additional range of potential confounding factors which need to be considered when comparing swimming in different contexts. We argue that to fully understand the potential benefits of open-water swimming, ideally these experiences would be compared to open-air swimming in more human-made contexts, which are more comparable in terms of openness to the elements. In short, it is important to quantify the additional benefits of open-water swimming, over and above not just swimming *per se* (Chamberlain et al., 2019), but also outdoor swimming in general.

Quantitative studies on the benefits of open-water swimming have also tended to use comparatively small samples or are limited to relatively small geographical regions (Demori et al., 2021; Huttunen et al., 2004; Lindeman et al., 2002; Maharja et al., 2023; Massey et al., 2020), which raises questions regarding generalisability, especially across countries with different climates and swimming cultures. The data have often only been collected during a single season, with many studies focusing on cold-water winter swimming (Demori et al., 2021; Huttunen et al., 2004; Lindeman et al., 2002), again limiting the generalisability of results.

Finally, qualitative studies have identified that some people report that open-water swimming can be challenging and anxiety inducing, although for some, such experiences may be part of the attraction (Britton & Foley, 2021). To date, however, the possibility of ambivalent emotions (both positive and negative emotions simultaneously) does not seem to have been explored in larger-scale quantitative studies.

The current research attempts to address several of these research gaps and aims to quantify associations between self-reported positive and negative well-being outcomes and swimming in open-air pool and open-water (wild) swimming locations. As shown in Fig. 1, we wanted to specifically test, *a priori*, the extent to which the three intrinsic needs proposed by SDT (Deci & Ryan, 2000) might help account for any psychological well-being benefits of open-water swimming (Thompson & Wilkie, 2021). Second, we wanted to explore whether open-water swimming and open-air pool swimming satisfied these needs to differing extents. Finally, using the same approach, we also looked at negative aspects of well-being related to both open-air pool and open-water swimming. Using a 19-country dataset incorporating seasonal waves (survey waves conducted at four different times of the year), we were able to increase the generalisability of our findings.

Fig. 1 presents an overview of our research questions and hypotheses. Based on the literature to date we expected that open-water vs. open-air pool swimming would be associated with greater positive subjective well-being (H1) and that this would be mediated by the three SDT dimensions of autonomy (H2a), relatedness (H2b) and competence (H2c). In other words, we predicted that open-water vs. open-air pool swimming would be associated with higher positive well-being because it would be related to higher feelings of freedom, social connections, and competence. Given the much smaller literature on, and potential ambivalent nature of, negative emotions, our examination of feelings of anxiety was more open-ended and exploratory. Specifically, we explored whether open-water swimming would be associated with more or less anxiety than open-air pool swimming (RQ1), and again whether any pattern may be mediated by feelings of autonomy (RQ2a), relatedness (RQ2b) and competence (RQ2c).

## 2. Methods

### 2.1. Sample and survey

Data were drawn from the BlueHealth International Survey (BIS; Elliott & White, 2022), exploring recreational use of natural environments, particularly focusing on blue spaces and various health and well-being outcomes (Grellier et al., 2017). The first set of data were

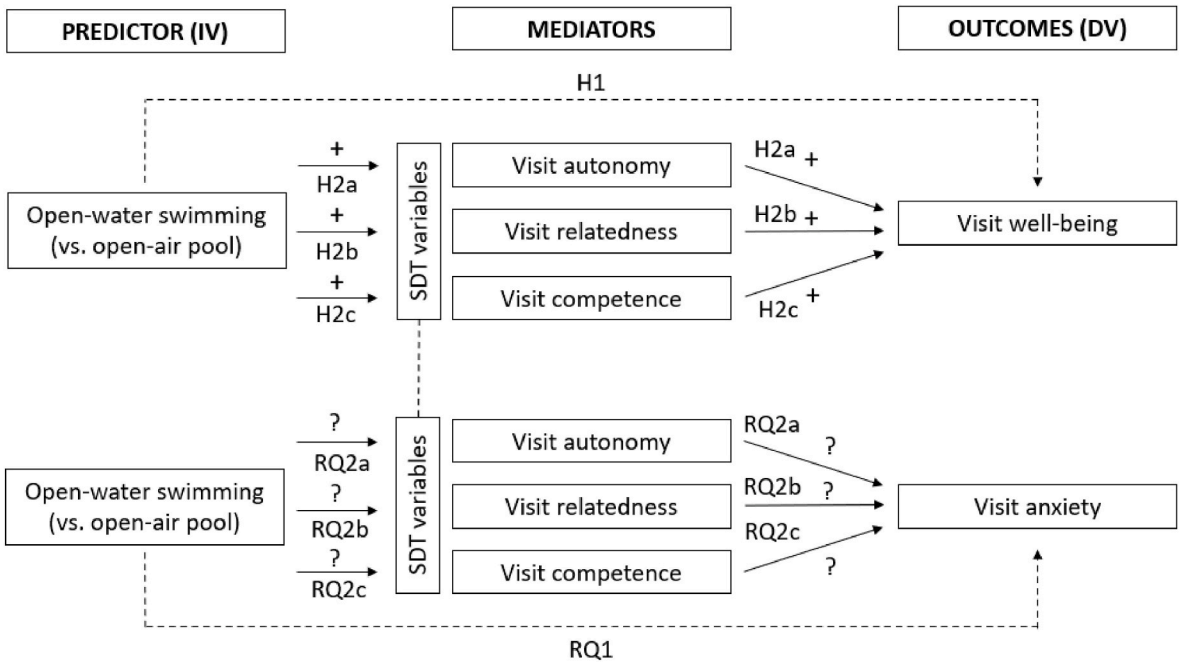


**Fig. 1.** Schematic representation of the hypothesised associations between open-water (vs. open-air pool) swimming and subjective well-being and mediating pathways based on self-determination theory.
*Note.* Dotted lines for direct associations, solid lines for paths via mediators. +H reflects directional Hypotheses and ?RQs reflect open-ended Research Questions.

collected in 14 European countries (Bulgaria, the Czech Republic, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and the United Kingdom) and four regions outside of Europe (Hong Kong, Canada, Australia [primarily Queensland] and the USA [only California]) with samples collected in four seasonal waves during 2017–2018. Samples were typically representative on interlocking age, gender, and region quotas and were approximately 1000 per country. An Austrian booster sample (n = 2514) was added in October 2020 (one wave only). The survey was administered by an international market research company using online survey panels.

Ethical approval for the methods, content and data management of the anonymised survey was granted by the University of Exeter's College of Medicine and Health Research Ethics Committee (Ref: Aug16/B/099). Full methodological details of the BIS are available on the Open Science Framework website: https://doi.org/10.17605/OSF.IO/7AZU2.

The full 19-country sample consisted of 21,352 respondents, with the overall survey asking about a number of different green and blue space exposure and outcome measures, e.g. where they lived, their general health, physical activity levels, social relations and so forth (e.g. see Elliott et al., 2023). We used responses to questions on the frequency of recreational visits to different green and blue spaces in the last four weeks, stressing that these "should not include private locations such as your own garden, land, pond or swimming pool". Following discussion with experts in the consortium, we selected a list of 17 types of blue spaces for respondents to choose (e.g. "natural or artificial lake or reservoir", "rural river/canal", "sandy beach or dunes", "open sea", etc.). If respondents reported visiting any of these environments at least once in the last four weeks, they were asked to provide more details about their most recent visit, including the main activity undertaken (from a list of 30, including "walking", "fishing", "boating" and "swimming") and a range of evaluations about the experience (including subjective well-being concerning the visit and statements relating to the three SDT constructs).

Of the original sample, n = 1200 people (5.62% of the overall survey respondents) were selected as the analytical sample, reporting that the main activity on their most recent visit was "swimming", with n = 355 reporting that this had taken place in an *open-air pool* (i.e. "outdoor public pool, lido or thermal spa") and n = 845 reporting that this had occurred in an *open-water setting* (e.g. "rural river/canal", "rocky or stony shore", "sandy beach or dunes" etc.). More details can be seen in Supplementary Materials Table S1. Two of the 17 settings where swimming could not logically take place, ice rinks and fountains were excluded. Of these 1200 participants 611 (50.92%) were female. The age distribution was also very balanced: n = 257 (21.42%) between 18 and 29 years; n = 232 (19.33%) between 30 and 39 years; n = 234 (19.50%) between 40 and 49 years; n = 231 (19.25%) between 50 and 59 years; and n = 246 (20.5%) were 60 years or older. Countries with some of the highest levels of reported outdoor swimming (regardless of swimming location) were Greece (15.15% of total blue space visits = swimming visits), Austria (13.48%), Spain (10.06%), Australia (7.29%), the Czech Republic (6.20%), and Italy (5.82%). Most swimming visits (61%) took place in late summer-early autumn. The remaining visits took place in late spring-early summer (26%), in late winter-early spring (7%), and in late-autumn early winter (6%).

### 2.2. Measures

#### 2.2.1. Positive subjective well-being and anxiety

Our key outcome measures of subjective well-being during the most recent visit were adapted from the four measures recommended by the UK's Office for National Statistics (Office of National Statistics, 2011) that were also subsequently adapted by the Organisation of Economic Cooperation and Development (Organisation for Economic Cooperation and Development OECD, 2013). This approach has single item measures of evaluative well-being (operationalised as overall life satisfaction), eudaimonic well-being (operationalised as feeling that one's activities in life are worthwhile), positive hedonic well-being (operationalised as happiness yesterday) and negative hedonic well-being (operationalised as anxiety yesterday). These items were adapted to be more specific to a single visit (Garrett et al., 2023), with participants asked to say how much they agreed with the following four statements about their most recent blue space visit: "I was satisfied with the visit", "I found the visit worthwhile", "it made me feel happy", and "it made me feel anxious",

with responses ranging from "Strongly disagree" (1) to "Strongly agree" (7), converted here to a −3 to +3 scale for ease of interpretation. Given high positive correlations between the three positive well-being items (*rs* > 0.68) they were collapsed into a single positive well-being scale (Cronbach's α = .90) to test H1 and H2, while "it made me feel anxious" was left as a single item to explore RQ1 and RQ2 (of note, anxiety correlated moderately negatively with the three positive items *rs* −0.32 to −0.36).

#### 2.2.2. Proposed mediators

The three SDT variables that were included in the BIS were adapted from similar SDT items in the physical activity domain more broadly (Markland & Tobin, 2004; see Elliott & White, 2022, for more details). They were measured as follows: "I felt free to be who I am" (autonomy), "I felt closeness or intimacy with others" (relatedness), and "I felt a sense of achievement" (competence), with the same 7-point Likert scale response recoded to a −3 to +3 scale. The correlations between the three items were positive, but small to medium (*rs* 0.36 to 0.40), suggesting they were measuring related but separate constructs that could be included separately in the modelling.

#### 2.2.3. Covariates

A range of variables may influence both the probability that someone may choose to swim in either an open-air pool or open-water setting and their experiences on such a visit. Previous research on the well-being effects of nature-based recreation (e.g. Martin et al., 2020) suggests these are likely to include both person-level variables (such as age and income) and visit-level characteristics (such as companions and activity duration). To reduce the possibility that these factors may confound any relationships between swimming location and well-being, we included them as covariates in the models, as well as season and country of residence.

Potential individual-level confounders included: Gender (female [ref], male); Age years (18–29 [ref], 30–39, 40–49, 50–59, 60+); Limiting long-term illness/disability (no [ref], yes); Self-reported minority ethnic status (no [ref], yes, Unsure/prefer not to answer); Household income in quintiles (1st lowest [ref], 2nd, 3rd, 4th, 5th highest, prefer not to answer). Potential visit-level confounders included: Other adults on visit (no [ref], yes); children present (no [ref], yes); day of the week (weekday [ref], weekend); mode of transport to site (taxi/hire [ref], private motorised transport, public transport, active travel, other); swimming visit duration (0–30mins [ref], 31–60mins, 61–90mins, 91–120mins, >120mins); time of day (morning [6:00–12:55, ref], "afternoon" [13:00–17:55], "evening" [18:00–22:55] and "night" [23:00 to 5:55]; perceived water quality (poor/sufficient [ref], good/excellent), and season (spring, summer, autumn, winter [ref]).

While missing data were generally not included in the analytical sample, we did create a "prefer not to answer" missing response for income to avoid losing a substantial number of people in the analyses who chose not to disclose this (n = 168). Country of residence was grand-mean coded in analyses such that the overall mean across all countries was included in the intercept (i.e. reference); and each country-specific slope indicated country-specific deviations from this overall mean.

Finally, to control for the possibility that people who visit open-air pools or open-water locations to swim had higher recent well-being in general, we also controlled for subjective well-being using the World Health Organisation 5-item wellbeing index (WHO-5; Mitchell et al., 2015) which asks the extent to which people have felt cheerful, calm, active, fresh, and interested in the last two weeks. Scores were collapsed and multiplied by four to form a 0–100 scale (Topp et al., 2015; here Cronbach's α = .92).

### 2.3. Statistical analysis

Data analysis was conducted in R version 4.3.2. (R Core Team, 2023), using the following packages: correlation (v. 0.8.3; Makowski et al., 2022), lavaan (v. 0.6.17; Rosseel, 2012), psych (v. 2.4.1; Revelle, 2024), tidySEM (v. 0.2.6; van Lissa, 2023), and tidyverse (2.0.0; Wickham et al., 2019). Preliminary analyses compared open-water and open-air pool swimming in terms of well-being outcomes using t-tests, and dummy coded covariates using chi-squared tests (χ2). Regression analyses predicting the main outcome variables (positive visit subjective well-being, and negative subjective well-being) as a function of swimming locations were conducted in two steps; first with swimming location (open-air vs. open-water) and all covariates included and second with the three SDT variables also added. If any relationship between swimming location and well-being was reduced when these three variables were added, and one or more SDT variables were themselves significant predictors of well-being, it could be indicative of potential mediation and support conducting our main structural equation modelling (SEM) approach. The outputs for these regressions are presented in Supplementary Materials Table S2.

Two separate SEMs were used to test the effects of swimming destination on visit-related: a) positive subjective well-being (H1 and H2), and b) negative subjective well-being (RQ1 and RQ2). The models were structured as per Fig. 1 but also included all covariates discussed above (not shown in Fig. 1 for ease of interpretation). The SEMs used maximum likelihood estimation with optimization method NLMINB and a bootstrap resample of 5000 for each model. Due to missing data on one or more variables the analytical samples for the positive well-being model were n = 1194 and for the negative well-being model n = 1193. Since our aim was to test a pre-specified model, rather than identify the most parsimonious one, both models were saturated (i.e. all possible pathways were connected) and thus model fit statistics are not reported (since fit was perfect).

Although the range of open-water locations was too large (and number of individuals in each location too small) to conduct separate SEMs for each specific location, we also conducted sensitivity analyses on the combined coastal water visits (e.g. sandy beaches, rocky shores, open sea etc.) and inland water visits (e.g. urban and rural rivers and lakes) to explore whether patterns may be similar or different for these two broad types of water category. These models are presented in the Supplementary Materials Figs. S1 and S2.

## 3. Results

### 3.1. Preliminary analyses

Table 1 presents Means (*Ms*) and Standard Deviations (*SDs*) for positive subjective well-being items (individual items and three combined) the negative well-being item (anxiety only), and the three mediation variables (autonomy, relatedness and competence) as well as the correlations between them. On scales of −3 (strongly disagree) to +3 (strongly agree), the averages for all variables (except anxiety) were positive ranging from $M = 0.88$ ($SD = 1.53$) for relatedness to $M = 2.20$ ($SD = 0.96$) for satisfaction. Likewise, anxiety was low: $M = -1.97$ ($SD = 1.36$). Supporting previous research, outdoor swimming visits were generally seen as highly positive experiences. Positive well-being items had small to large positive correlations with the three SDT variables (*rs* ranged from 0.25 to 0.72). Anxiety was negatively related to autonomy ($r = -0.31$) but unrelated to relatedness and competence (*rs* = −0.01 to −0.04).

Supporting H1, Table 2 shows that although both locations were associated with positive well-being overall, open-water visits were associated with significantly higher satisfaction, worthwhileness, happiness, autonomy, relatedness, and competence (all *ts* > 4.00; *ps* < 0.001). There was, however no significant difference in anxiety between locations (i.e. RQ1, $t = 1.44$, $p = .150$). Supplementary Materials

**Table 1**
Means (M) and standard deviations (SD) of, and correlations (*r*) between, key subjective well-being outcomes and mediation (self-determination) variables.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| *Positive well-being* | | | | | | | | |
| 1 Satisfied | $M = 2.20$ $SD = 0.94$ | | | | | | | |
| 2 Worthwhile | 0.80*** | $M = 2.19$ $SD = 0.98$ | | | | | | |
| 3 Happy | 0.70*** | 0.68*** | $M = 2.09$ $SD = 1.04$ | | | | | |
| 4 All positive well-being | 0.92*** | 0.91*** | 0.88*** | $M = 2.16$ $SD = 0.89$ | | | | |
| *Negative well-being* | | | | | | | | |
| 5 Anxious | −0.36*** | −0.32*** | −0.34*** | −0.37*** | $M = -1.97$ $SD = 1.36$ | | | |
| *Self-determination* | | | | | | | | |
| 6 Autonomy | 0.68*** | 0.64*** | 0.62*** | 0.72*** | −0.31*** | $M = 1.96$ $SD = 1.12$ | | |
| 7 Relatedness | 0.27*** | 0.25*** | 0.30*** | 0.30*** | −0.04 | 0.36*** | $M = 0.88$ $SD = 1.53$ | |
| 8 Competence | 0.29*** | 0.30*** | 0.35*** | 0.35*** | −0.01 | 0.40*** | 0.37*** | $M = 0.93$ $SD = 1.43$ |

***$p < .001$.

**Table 2**
Relationships between swimming location and self-reported visit positive and negative well-being and self-determination variables, plus recent subjective well-being as covariate.

| | Open-air pool swimming | | Open-water swimming | | *t-tests/p* values |
|---|---|---|---|---|---|
| | *n* | *M* (*SD*) | *n* | *M* (*SD*) | |
| *Visit positive well-being*[a] | | | | | |
| Satisfied | 354 | 1.97 (0.95) | 844 | 2.30 (0.93) | $t = 5.57$, $df = 1196$, $p < .001$ |
| Worthwhile | 355 | 1.97 (0.95) | 844 | 2.28 (0.97) | $t = 5.10$, $df = 1197$, $p < .001$ |
| Happy | 355 | 1.88 (0.95) | 844 | 2.18 (0.95) | $t = 4.65$, $df = 1197$, $p < .001$ |
| Combined positive[b] | 354 | 1.94 (0.91) | 844 | 2.25 (0.87) | $t = 5.66$, $df = 1197$, $p < .001$ |
| *Visit negative well-being*[a] | | | | | |
| Anxious | 354 | −1.88 (1.31) | 844 | −2.01 (1.38) | t = 1.44, $df = 1196$, $p = .150$ |
| *Visit SDT*[c] | | | | | |
| Autonomy | 355 | 1.64 (1.17) | 843 | 2.10 (1.08) | $t = 6.51$, $df = 1196$, $p < .001$ |
| Related | 355 | 0.55 (1.54) | 845 | 1.02 (1.50) | $t = 4.95$, $df = 1198$, $p < .001$ |
| Competence | 355 | 0.67 (1.04) | 844 | 1.04 (1.46) | $t = 4.06$, $df = 1197$, $p < .001$ |

*Notes*.
[a] Responses ranged from −3 (strongly disagree) to +3 (strongly agree).
[b] The combined positive well-being measure was used to test H1 & H2.
[c] SDT = Self-determination theory; Different Ns reflect missing data.

Table S3 compares the two locations in terms of individual- and visit-level covariates. While there were no differences in terms of gender, age, limiting illness/disability, or ethnicity there was a positive relationship with household income. In general, individuals from wealthier households were more likely to report outdoor swimming in either location, but there was also some indication that swimming visits among individuals in poorer households were more likely to occur in open-water locations (lowest quintile = 78%) than among those in wealthier households (richest quintile = 65%).

In terms of visit-level characteristics, people were more likely to be with another adult, but less likely to be with children on an open-water swim. People were more likely to take public transport to open-air pools than open-water sites with the reverse for personal motorised transport, active travel, and taxi/hire cars. Open-water swimming visits tended to be shorter than open-air pool visits and more likely to occur in the summer, while there were no differences across the two types of location in terms of time of day or perceived water-quality. Open-water swims were more prevalent than open-air pool swims for respondents from Australia, Bulgaria, Estonia, France, Finland, Greece, Ireland, Italy, Portugal, Spain, Sweden, and Austria. Contrastingly, open-water swims were less prevalent than open-air pool swims in California, Canada, Czech Republic, Hong Kong, the Netherlands, and the UK. Respondents from Germany reported swimming equally in both location types. People who reported open-water swims also reported higher general well-being over the previous two weeks than those who reported open-air pool swims, highlighting why it is important to control for this when comparing experiences in the two locations in our regression and SEM models.

Finally, before running the main regression models predicting well-being outcomes we ran ordinary least squared (OLS) regression models on the three SDT variables to check if the associations between them and well-being seen in Table 1 held after controlling for all individual- and visit-level covariates. Results are presented in Supplementary Table S2 and confirm that open-water swims were still associated with greater autonomy ($b = 0.30$; $p < .001$), greater relatedness ($b = 0.42$; $p < .001$), and greater competence ($b = 0.28$; $p < .001$), than open-air pool swims.

In addition, males and older adults tended to report higher overall levels of autonomy than females and younger adults. Relatedness was higher, not surprisingly, when other adults were on the swim visit, and for longer visits. Visits by males, those with at least some limiting illness/disability, and on weekends were associated with higher levels of competence than visits by females, those without physical health limitations, and on weekdays. Perceived good water quality was positively associated with all three outcomes, as was general well-being (WHO-5). Relationships with country were quite varied, but given the low numbers of visits for some countries we are cautious about over-interpreting these here, although recognise the importance of controlling for country because of these patterns.

### 3.2. Regression models (H1 and RQ1)

The main regression analyses relating to positive well-being and negative well-being are presented in Table 3. Supporting H1, and the simple *t*-test in Table 2, positive well-being continues to be higher for open water than open-air pool swimming visits, even after controlling for individual- and visit-level covariates (first data column: $b = 0.62$; $p < .001$). Supporting potential mediation by the three SDT variables

**Table 3**
OLS regression models predicting positive and negative well-being with and without the three self-determination variables (autonomy, relatedness and competence) included as a function of swimming location, personal-level and visit-level covariates.

| | Positive well-being (without SDT) | | Positive well-being (with SDT) | | Negative well-being (without SDT) | | Negative well-being (with SDT) | |
|---|---|---|---|---|---|---|---|---|
| | *b* | *(SE)* | *b* | *(SE)* | *b* | *(SE)* | *b* | *(SE)* |
| ***Swimming location*** | | | | | | | | |
| Open water (*ref* = open-air pool) | 0.62*** | (0.17) | 0.13 | (0.14) | −0.06 | (0.09) | 0.02 | (0.09) |
| ***Individual-level covariates*** | | | | | | | | |
| Gender | | | | | | | | |
| Male (*ref* = Female) | −0.59*** | (0.15) | −0.31** | (0.12) | 0.34*** | (0.08) | 0.29*** | (0.08) |
| Age yrs (*ref* = 18–29 yrs) | | | | | | | | |
| 30-39 | 0.51* | (0.23) | 0.22 | (0.18) | 0.08 | (0.13) | 0.12 | (0.13) |
| 40-49 | 0.90*** | (0.23) | 0.36* | (0.17) | −0.25* | (0.12) | −0.20 | (0.12) |
| 50-59 | 0.92*** | (0.23) | 0.33 | (0.19) | −0.48*** | (0.11) | −0.34** | (0.11) |
| 60+ | 0.68*** | (0.22) | 0.27 | (0.17) | −0.37** | (0.11) | −0.25* | (0.11) |
| Limiting illness/disability (*ref* = none) | | | | | | | | |
| Some | −0.28 | (0.16) | −0.27* | (0.13) | 0.22** | (0.08) | 0.18* | (0.08) |
| Self-reported ethnicity (*ref* = majority) | | | | | | | | |
| Minority | −0.07 | (0.30) | −0.30 | (0.23) | 0.17 | (0.16) | 0.20 | (0.16) |
| Unsure | 0.25 | (0.40) | 0.41 | (0.30) | 0.70** | (0.27) | 0.65* | (0.27) |
| Household income (*ref* = lowest quintile) | | | | | | | | |
| Quintile 2 | −0.30 | (0.25) | −0.20 | (0.20) | −0.09 | (0.15) | −0.10 | (0.15) |
| Quintile 3 | −0.69* | (0.28) | −0.26 | (0.21) | 0.06 | (0.15) | −0.02 | (0.15) |
| Quintile 4 | 0.14 | (0.24) | 0.34 | (0.17) | −0.27 | (0.14) | −0.30* | (0.14) |
| Quintile 5 (highest income) | −0.59* | (0.26) | −0.18 | (0.19) | −0.26 | (0.15) | −0.34* | (0.14) |
| Prefer not to say | −0.40 | (0.28) | −0.10 | (0.21) | −0.26 | (0.14) | −0.30* | (0.13) |
| General well-being (WHO-5) | 0.03*** | (>0.01) | 0.00 | (>0.01) | −0.01*** | (>0.01) | >-0.01 | (>0.01) |
| ***Visit-level covariates*** | | | | | | | | |
| ≥1 other adult (*ref* = Alone) | 0.05 | (0.16) | −0.03 | (0.14) | −0.07 | (0.09) | −0.09 | (0.09) |
| ≥1 Child (*ref* = 0 Children) | −0.35 | (0.29) | 0.04 | (0.24) | 0.04 | (0.14) | −0.08 | (0.14) |
| Weekend (*ref* = weekday) | 0.32* | (0.15) | 0.12 | (0.11) | −0.04 | (0.08) | −0.01 | (0.08) |
| Transport (*ref* = taxi/hire car etc.) | | | | | | | | |
| Private car, motorcycle, etc. | 0.62 | (0.38) | 0.76** | (0.27) | 0.07 | (0.14) | −0.01 | (0.12) |
| Public transport | 0.40 | (0.42) | 0.48 | (0.31) | 0.38* | (0.19) | 0.30 | (0.17) |
| Active transport (walked, cycled) | 0.56 | (0.43) | 0.68* | (0.30) | −0.03 | (0.18) | −0.09 | (0.16) |
| Other | 1.50* | (0.61) | 1.70** | (0.53) | −0.05 | (0.40) | −0.20 | (0.39) |
| Activity duration (*ref* = 1–39 min) | | | | | | | | |
| 40–60 min | 0.19 | (0.20) | 0.12 | (0.15) | −0.16 | (0.10) | −0.16 | (0.10) |
| 70–90 min | 0.63** | (0.24) | 0.52** | (0.19) | −0.36** | (0.13) | −0.34** | (0.12) |
| 100–120 min | 0.45 | (0.23) | 0.23 | (0.17) | −0.13 | (0.13) | −0.10 | (0.13) |
| >120 min | 0.68** | (0.24) | 0.54** | (0.21) | −0.09 | (0.15) | −0.11 | (0.14) |
| Time of day (*ref* = Morning) | | | | | | | | |
| Afternoon | −0.02 | (0.15) | >0.01 | (0.12) | −0.07 | (0.09) | −0.07 | (0.08) |
| Evening | 0.57 | (0.35) | 0.16 | (0.22) | −0.30 | (0.18) | −0.19 | (0.17) |
| Night | −1.57** | (0.52) | −1.23** | (0.42) | 0.26 | (0.19) | 0.15 | (0.19) |
| Perceived water quality (*ref* = Poor) | | | | | | | | |
| Good | 1.77*** | (0.29) | 0.85*** | (0.23) | −0.37** | (0.14) | −0.20 | (0.13) |
| Season (*ref* = Winter) | | | | | | | | |
| Spring | −0.45 | (0.45) | −0.47 | (0.32) | 0.40 | (0.23) | 0.41 | (0.23) |
| Summer | 0.17 | (0.37) | 0.13 | (0.28) | −0.01 | (0.18) | 0.02 | (0.18) |
| Autumn | 0.23 | (0.37) | 0.20 | (0.28) | −0.10 | (0.18) | −0.06 | (0.18) |
| Country (*ref* = Grand mean) | | | | | | | | |
| Australia | 0.27 | (0.30) | −0.05 | (0.25) | −0.04 | (0.19) | 0.02 | (0.17) |
| Bulgaria | 1.08*** | (0.30) | 0.35 | (0.19) | −0.33* | (0.14) | −0.16 | (0.14) |
| California | 1.04* | (0.47) | 0.79** | (0.35) | −0.16 | (0.23) | −0.09 | (0.24) |
| Canada | 0.48 | (0.60) | 0.13 | (0.56) | -0–06 | (0.31) | 0.01 | (0.32) |
| Czech Republic | 0.03 | (0.33) | −0.02 | (0.25) | −0.11 | (0.17) | −0.09 | (0.16) |
| Estonia | −0.82 | (0.51) | −0.86* | (0.40) | 0.33 | (0.20) | 0.31 | (0.21) |
| Finland | 0.02 | (0.59) | 0.33 | (0.48) | −0.80*** | (0.17) | −0.96*** | (0.18) |
| France | −0.39 | (0.45) | −0.39 | (0.32) | 0.02 | (0.27) | −0.10 | (0.27) |
| Germany | −0.68 | (0.45) | 0.05 | (0.32) | −0.19 | (0.18) | −0.29 | (0.16) |
| Greece | 0.48* | (0.20) | 0.25 | (0.15) | 0.08 | (0.12) | 0.10 | (0.12) |
| Hong Kong | −0.63 | (0.32) | −0.02 | (0.27) | 0.23 | (0.19) | 0.04 | (0.20) |
| Ireland | −1.09 | (0.68) | −0.39 | (0.50) | 0.26 | (0.31) | 0.09 | (0.31) |
| Italy | −0.12 | (0.27) | −0.36 | (0.21) | 0.15 | (0.20) | 0.17 | (0.17) |
| Netherlands | −0.58 | (0.37) | −0.56 | (0.30) | 0.16 | (0.28) | 0.22 | (0.26) |
| Portugal | 0.20 | (0.32) | 0.12 | (0.22) | 0.47* | (0.20) | 0.54** | (0.21) |
| Spain | −0.47 | (0.28) | 0.29 | (0.20) | 0.44** | (0.17) | 0.40** | (0.14) |
| Sweden | −0.07 | (0.57) | −0.06 | (0.43) | -0–08 | (0.36) | 0.02 | (0.35) |
| United Kingdom | 0.99 | (0.71) | 0.76* | (0.37) | −0.10 | (0.48) | 0.04 | (0.44) |
| Austria[a] | 0.27 | (0.27) | 0.45* | (0.23) | −0.25 | (0.13) | −0.26 | (0.13) |
| ***SDT***[b] | | | | | | | | |
| Autonomy | – | – | 1.43*** | (0.09) | – | – | −0.40*** | (0.05) |
| Relatedness | – | – | 0.03 | (0.05) | – | – | 0.06* | (0.03) |

(*continued on next page*)

**Table 3** (*continued*)

| | Positive well-being (without SDT) | | Positive well-being (with SDT) | | Negative well-being (without SDT) | | Negative well-being (with SDT) | |
|---|---|---|---|---|---|---|---|---|
| | *b* | *(SE)* | *b* | *(SE)* | *b* | *(SE)* | *b* | *(SE)* |
| Competence | – | – | 0.18*** | (0.05) | – | – | 0.10*** | (0.03) |
| $R^2$ | 27.00% | | 56.80% | | 16.70% | | 23.60% | |

(H2a, b c), this association becomes non-significant when they are added (second data column: $b = 0.13$, $p = .368$). However, only autonomy (H2a: $b = 1.43$; $p < .001$) and competence (H2c: $b = 0.18$; $p < .001$), but not relatedness (H2b: $b = 0.03$, $p = .531$) are positively related to positive well-being suggesting any mediation is possibly only occurring for these two dimensions.

In this full model, males (vs. females), those aged 40–49yrs (vs. 18–29yrs), those with some (vs. no) limiting health issues, and those who used private motorised or active (walking/cycling) transport (vs. taxi/hire car), and who visited for 70–90 or >120 min (vs. < 40mins), at night (vs. morning), and to locations with good (vs. poor) perceived water quality also reported higher positive-wellbeing. Compared to the country mean, swimming visits by people in California, Estonia, UK, and Austria were also associated with higher well-being scores. Overall, the model explains nearly 57% of the variance in positive well-being on swimming visits.

Concerning RQ1, and also reflecting the simple *t*-test in Table 2, anxiety was again not different as a function of swimming location after controlling for individual- and visit-level covariates (third data column: $b = -0.06$, $p = .538$). This association remained non-significant when the three SDT variables were added (RQ2, third data column: $b = 0.02$; $p = .866$). This time, however, all three SDT variables were significantly associated with negative well-being (fourth data column) with autonomy being negatively related ($b = -0.40$; $p < .001$) but both relatedness ($b = 0.06$; $p < .05$) and competence ($b = 0.10$; $p < .001$) being positively related (i.e. feeling more autonomous was associated with lower anxiety levels, but feeling more relatedness or more competence was associated with higher anxiety levels).

In this full model, males (vs. females), and those with some (vs. no) limiting health issues, reported higher levels of negative well-being, while those aged 50–60+yrs (vs. 18–29yrs), living in wealthier (quintiles 4 and 5) vs. poorer (quintile 1) households, and visiting for 70–90mins (vs. < 40mins) reported less negative well-being. Compared to the country mean, swimming visits by people in Finland were associated with lower anxiety scores while those by people in Portugal and Spain were associated with higher anxiety scores. Overall the model explained nearly 24% of the variance in negative well-being on swimming visits.

Given that swimming in open-water (vs. open-air pools) was positively associated with all three SDT dimensions (see preliminary analyses above and Supplementary Materials Table S2) the multi-directional associations between the SDT variables in this model suggest that the overall null association may be due to two counteracting processes cancelling each other out. Specifically, while the greater autonomy associated with open-water (vs. open-air pool) swimming was associated with reduced anxiety, the greater relatedness and competence associated with open-water (vs. open-air pool) was associated with increased anxiety. We return to why this might have occurred in the Discussion. Of relevance here is the fact that the planned mediation analyses using SEMs are able to explore this possibility in a way the simple regression models in Table 3 are unable to.

### 3.3. Structural equation models

Results for the SEM models testing H1 and H2 (positive well-being) and exploring RQ1 and RQ2 (anxiety) are shown in Figs. 2 and 3 respectively and Table 4. In both cases the main predictor is swimming location (open-water vs. open-air pool), the three SDT variables were included as potential mediators in parallel, and the individual-level and visit-level variables included as covariates (but not shown in Figs. 2 and 3 for ease of interpretation). For both models open-water vs. open-air pool swimming visits were associated with significantly higher autonomy (β = 0.30, $p < .001$), relatedness (β = 0.42, $p < .001$) and competence (β = 0.28, $p < .01$), replicating the regression results in Supplementary Table S2. Swim location, covariates, and covariances between the three SDT variables, explained 24.5% of the variance in autonomy, 21.2% in relatedness, and 20.3% in competence.

#### 3.3.1. H2: Mediation of SDT variables on positive well-being

Consistent with the full regression model (Table 3), there was no direct association between swimming location and positive well-being (β = 0.13, 95% CIs [−0.14, 0.40]). And as suggested by that model, significant indirect effects of open-water swimming (vs. open air pool swimming) on positive well-being were found via greater autonomy (β = 0.43, 95% CIs [0.23, 0.64]) and competence (β = 0.05, 95% CIs [0.01, 0.1]), but not relatedness (β = 0.01, 95% CIs [−0.03, 0.06]) (Table 4).

#### 3.3.2. RQ2: Mediation of SDT variables on anxiety

Again, consistent with the full regression model (Table 3), there was no overall total effect of swimming location on anxiety (β = −0.05, 95% CIs [−0.24, 0.13]). However, this time the SEM revealed a more complex pattern than for positive well-being. Specifically, there was a

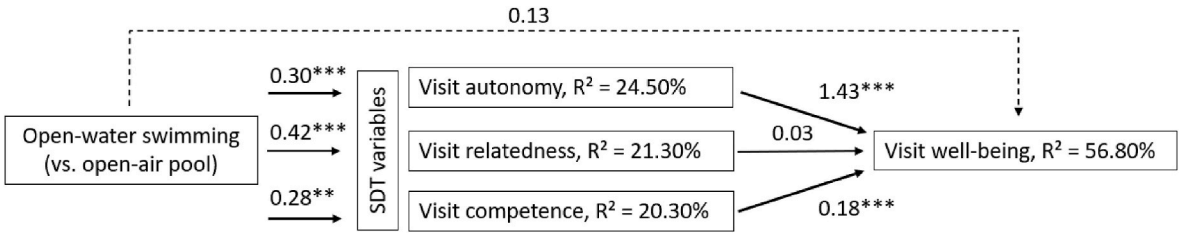


**Fig. 2.** Mediation model for (combined) positive visit well-being

*Note*. Significant indirect effects of open-water swimming via autonomy (β = 0.43, 95% CIs [0.22, 0.64]) and competence (β = 0.05, 95% CIs [0.01, 0.10]) are highlighted with bold arrows. Although not shown the model includes the following covariates: gender, age, limiting illness/disability, self-reported ethnicity, household income, general wellbeing (WHO5-wellbeing index), visiting in company of other adults (vs. alone), visiting with children (vs. without), weekday (vs. weekend), type of transport, activity duration, time of day, perceived water quality, season, and country.

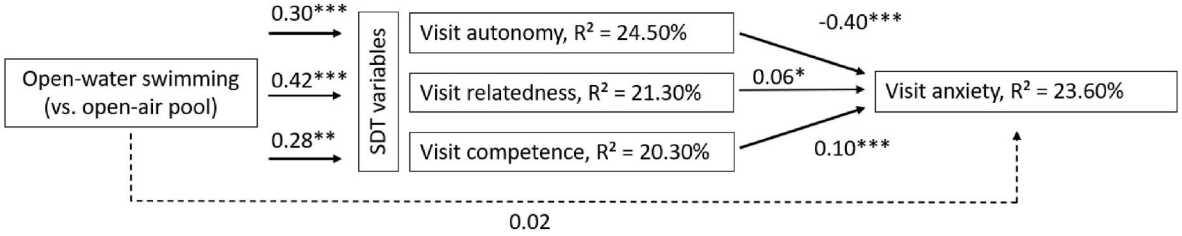


**Fig. 3.** Mediation model for negative visit well-being (anxious)
*Note.* Significant indirect effects of open-water swimming via autonomy (β = −0.12, 95% CIs [-0.19, −0.06]) and competence (β = 0.03, 95% CIs [0.01, 0.06]) are highlighted with bold arrows. Although not shown the model includes the following covariates: visit duration, gender, age, disability, visit time, visit mode, perceived minority status, visiting in company of other adults (vs. alone) visiting with children (vs. without), household income, water quality at visit site, weekday (vs. weekend), season, country and general wellbeing (WHO5-wellbeing index).

**Table 4**
Indirect effects for positive and negative visit well-being via the three SDT variables.

| | Positive well-being | | Negative well-being (anxiety) | |
|---|---|---|---|---|
| | *β* | *(95% CIs)* | *β* | *(95% CIs)* |
| Direct effect | 0.13 | (-0.14, 0.40) | 0.02 | (-0.16, 0.19) |
| Indirect via autonomy | 0.43*** | (0.21, 0.64) | −0.12*** | (-0.19, −0.06) |
| Indirect via relatedness | 0.01 | (-0.03, 0.05) | 0.03 | (0.00, 0.06) |
| Indirect via competence | 0.05* | (0.01, 0.10) | 0.03* | (0.01, 0.06) |
| Indirect total | 0.49*** | (0.26, 0.72) | −0.07* | (-0.14, −0.01) |
| Total = indirect + direct | 0.62*** | (0.29, 0.95) | −0.05 | (-0.24, 0.13) |

significant negative total indirect effect (β = −0.07, 95% CIs [−0.14, −0.01]), that was to some extent cancelled out via the small and non-significant positive direct effect (β = 0.02, 95% CIs [−0.16, 0.20]). However, the pattern is more complex still because while autonomy mediated the association in a negative fashion (β = −0.12, 95% CIs [−0.19,0.06]), competence mediated the association in a positive fashion (β = 0.03, 95% CIs [0.01,0.06]).

That is, open-water swims were associated with both higher autonomy and competence than open-air pool swims, but while greater feelings of autonomy were associated with lower feelings of anxiety, greater feelings of competence were associated with higher levels of anxiety (see Discussion for possible explanation). Again, in combination with the slightly positive direct effect, these contradictory patterns helped to render the overall association non-significant. As with positive well-being there was no mediation effect of relatedness (β = 0.03, 95% CIs [0.00, 0.06]).

### 3.4. Sensitivity analysis: coastal and inland outdoor swimming

Results for the separate open-water coastal and inland swimming locations (vs. open-air pools) can be seen in Supplementary Fig. S1 (Coastal: positive and negative wellbeing) and Supplementary Fig. S2 (Inland: positive and negative wellbeing). The patterns were almost identical to the overall (combined) models (Figs. 1 and 2) suggesting that both open-water locations showed similar benefits relative to open-air pool swimming.

## 4. Discussion

### 4.1. Summary of main findings

Recent research highlights the potential health and well-being benefits of open-water swimming in natural settings like rivers, lakes, and the coast (Britton & Foley, 2021; Burlingham et al., 2022; Oliver et al., 2023). However, studies often face limitations, such as small, localised samples and difficulties in distinguishing benefits specific to open-water swimming from those of swimming in general or other outdoor swimming locations, such as open-air pools in particular (Overbury et al., 2023). Further, although the literature discusses a number of reasons why open water swimming may be particularly beneficial for well-being, there has been little attempt to combine these accounts under a unifying theoretical framework.

The aim of the current research was to address these research gaps. Specifically, we used data on 1200 outdoor swimming visits across 19 different countries to explore: a) whether open-water swimming may be associated with both greater positive and lower negative (anxiety) well-being compared to open-air pool swimming; and b) whether any associations might be explained via the mechanisms proposed by self-determination theory (Thompson & Wilkie, 2021), namely greater feelings of autonomy (personal freedom), relatedness (social connectedness) and competence (feelings of control and mastery; Ryan & Deci, 2022).

Results found that while recalled positive subjective well-being (in terms of happiness, worthwhileness and satisfaction) was already relatively high in open-air pools ($M = 1.94$, on a scale from −3 to +3), it was about 9% greater in open-water locations ($M = 2.25$). These results both support previous results by highlighting the benefits of outdoor swimming in general, and extend them by showing that: a) swimming in natural settings is associated with somewhat greater benefits than human-made locations; and b) that these findings hold after a range of potential confounders are accounted for. Results were very similar for both coastal and inland open-water settings, compared to open-air pools.

Given the extra challenges potentially faced in open-water vs. open-air pool locations we also explored negative well-being in the form of experienced anxiety. Results found that anxiety in both locations was low ($Ms = -1.88$; −2.01 respectively) and not significantly different. This finding supports the notion that open-water swimmers may be aware of the risks and take steps to mitigate them, potentially selecting locations where they are less likely to feel anxiety (Costello et al., 2019; McDougall et al., 2022a; Oliver et al., 2023; Wood et al., 2022).

Our results also partially support Thompson & Wilkie's (2021) suggestion that some of the well-being related benefits of blue space activities may be due to the satisfaction of intrinsic needs for autonomy, relatedness, and competence. Specifically, in line with the predictions of SDT, feelings of autonomy especially, and competence to a lesser degree, significantly mediated the relationship between open-water vs. open-air pool swims and self-reported positive well-being. In other words, the reason why people reported higher well-being on open-water than open-air pool swims was that they felt freer and in more personal control. These findings provide numerical support to the kinds of explanations open-water swimmers offer in more qualitative studies (e.g. Denton & Aranda, 2020; Lloret et al., 2023; Wood et al., 2022).

Given that Wood et al. (2022) reported that approximately 80% of open-water swims were undertaken with others and that a sense of

community is often given as a motivation for open-water swimming (Overbury et al., 2023), it is perhaps surprising that there was no mediation via relatedness. Of note, open-water swims were still associated with higher relatedness than open-air pool swims, but the mediation did not occur because there was no association between relatedness and positive well-being, at least when all covariates were controlled for (the bivariate relationship was significantly positive, $r = 0.30, p < .001$). We have no clear explanation for this finding, which seems to be due to the shared variance with the other aspects of SDT (i.e. Autonomy and Competence), but we may speculate that the presence of others helped people feel safer and more competent, and thus a parallel mediation model is not capturing the more complex patterns within the data.

The SDT related results for anxiety were even more complex. Specifically, although there was no overall association between swimming location (open-water vs. open-air pool) and anxiety, there was significant mediation through both autonomy and competence though in opposite directions. Greater feelings of freedom were associated with lower anxiety, but greater feelings of competence were, by contrast, associated with greater feelings of anxiety. While this may seem odd, it is perhaps consistent with Britton & Foley's (2021) observation that part of the attraction of open-water swimming and other water sports such as surfing is that they put one in challenging situations that test one's skills and competencies which can lead to greater anxiety, at least at the time. Moreover, in line with flow theory (Nakamura & Csikszentmihalyi, 2009), the greater competence, the greater the need to be challenged further, to avoid boredom, and these greater challenges can increase anxiety in the short-term. Although these suggestions are speculative, especially given low levels of anxiety on these swimming visits overall, the existence of similar interview-based evidence highlighting the complex relationships between open-water swimming and psychological well-being supports calls for mixed-methods research in helping to understand environment-psychology relations (Ratcliffe et al., 2023).

Despite these nuances, the current research found that the principle mediator for both positive and negative well-being was autonomy. Open-water swims were associated with greater feelings of being "free to be whom I am" than open-air pool swims and in turn this was associated with higher positive well-being and lower anxiety. Further, this finding appeared relatively similar across both inland open-water swims (e.g. lakes and rivers) and those at the coast.

The covariates also revealed some important results. For example, outdoor swimmers (in either location) had, on average, relatively higher well-being over the last two weeks. Specifically, WHO-5 levels across the entire BlueHealth data set (n ~ 21k) averaged around 60 (out of 100) across the 19 countries (Fian et al., 2024; White et al., 2021), while open-air pool swimmers reported WHO-5 scores of $M = 61.68$ and open-water swimmers reported $M = 65.20$ (Supplementary Table S3). The latter level of well-being was higher than all country-level averages except for Spain (White et al., 2021). In short, one of the reasons why levels of visit-related well-being were particularly high may be because happier people also tend to be those who are more likely to report swimming outdoors on their most recent blue space visit. Although this could be viewed as a confounder, it may also reflect the cumulative, or accretive, effect of regularly swimming outdoors (Foley, 2017). As we only had data on a single visit, we were unable to explore this issue here, and longitudinal studies are needed to understand potential cause and effect patterns (Burlingham et al., 2022; Massey et al., 2020).

Another notable finding was that outdoor swimmers, in general, tended to report living in higher income households. Although this may suggest that income-related inequalities may confound outdoor swimming-well-being associations, our data (Supplementary Table S3) show that while 78% of outdoor swimming visits among those in the lowest income quintile were to open-water locations, among those in the highest income quintile this was only 65%, with 35% of visits to open-air pools (which may be more likely to charge a fee for use). Although the literature on the ability of nature visits in general (Fian et al., 2024) and blue spaces in particular (Elliott et al., 2023; Geiger et al., 2023) to reduce income-related inequalities in health and well-being is mixed (Rigolon et al., 2021), some studies have suggested that access to the coast in particular is more beneficial for those in lower income households (Garrett et al., 2019). To the extent that people in lower income households use (safe) local wild blue spaces to go swimming for free, these activities may therefore help to reduce inequalities.

Finally, we note that open-water swims were more likely to occur with other adults, while open-air pool swims were more likely to take place with children. This may, in part, be due to safety concerns both in terms of: a) the child's swimming abilities; and b) having lifeguards and so forth on standby in many open-air pool situations. Familiarity with blue spaces during childhood is an important predictor of building intrinsic motivation to visit such places, and subsequent well-being, in adulthood (Vitale et al., 2022). Therefore, we may also be picking up a well-being trade-off here, such that adults may be ready to swim in a location that is associated with lower well-being for themselves in order to ensure their children have positive swimming experiences that can benefit them now and in later life. Without detailed understanding of specific visit motives this is clearly speculation at this stage.

### 4.2. Strengths and limitations

The main strengths of the current research include its large and diverse sample across multiple countries, which aids the generalisability of results. Further, we believe it is the first study to compare two forms of outdoor swimming, open-water swimming in natural places and open-air pool swimming in human-made settings. This enabled us to begin to tease out the "added value" of wild swimming compared to swimming outdoors more generally. Finally, by exploring people's visit-related satisfaction of the intrinsic needs for autonomy, relatedness, and competence, we found that a key psychological driver of greater well-being associated with open-water or wild swims was the feelings of autonomy and freedom to be who one wants to be without the restrictions imposed by open-air pool settings.

We also recognise several limitations. First, the data are self-report and relate to the most recent outdoor swimming visit within the last four weeks. Response and memory biases may thus be playing a role in our findings, although it is not obvious why any distortions would be systematically greater for one kind of swimming experience over the other. Some aspects, such as duration though, may reflect the entirety of the visit, rather than only the active swimming part it, so data still need to be treated with caution.

Second, although we were able to construct a three-item scale to measure positive well-being, negative well-being and all our mediators were measured with single survey items. Given the complexity of these constructs, single items are less likely to capture their underlying latent aspects than reliable scales, and thus our results are indicative only and await further testing with richer operationalisations. Our selection of single items, however, reflects the trade-off between more reliable and valid measures tested with (usually) smaller samples and fewer items collected with larger and more robust samples, with both approaches having their advantages and disadvantages (Allen et al., 2022).

Third, we recognise that our sample was not fully balanced in terms of swimming location, with more respondents reporting open-water swimming than open-air pool swimming. In part, this is likely to reflect the far greater opportunities for wild swimming, not just in terms of number of potential locations but also in terms of all-year round accessibility. Although we didn't have the data to explore this in depth, we also recognise that some locations, especially those far from the sea, are maybe more likely to invest in dedicated bathing sites and outdoor pool facilities. For instance, Vienna, which is several hundred kilometres from the sea, has seven major outdoor public swimming pools, as well as dozens of dedicated and maintained bathing beaches, of varying kinds, in and around the Danube basin (Arnberger et al., 2024). Similarly, Berlin offers 26 public outdoor pools (https://www.berlin.de/en/sports-leisure/swimming-pools/outdoor-pools/). Consequently, reported

experiences may to some extent be a function of different availability of options in different locations.

Fourth, and relatedly, despite our relatively large and heterogeneous sample for a study on specific swimming visits, we still lacked samples of sufficient power in specific countries to reliably compare across countries and season. Our results found that open-water swimming was more frequent than open-air pool swimming in 12/19 countries, and in all seasons except spring, but there was no obvious pattern in relation to location, climate and temperature. For instance, while open-water swimming was more prevalent in relatively cold climate countries such as Finland, Sweden and Estonia, our Californian sample was more likely to report swimming in an open-air pool (perhaps because there are more of them, see above). The collection of larger samples in each country across seasons, perhaps through a future collaborative data collection exercise across multiple research groups (see Baumeister et al., 2023 for a wider discussion) may help to explore these issues.

Fifth, the California findings raise another potential limitation with respect to open-air pool swims. Specifically, we asked for very few details about the exact swimming location and thus, although we expressly asked respondents to focus on public and not private blue spaces, we do not know for sure if people still reported swimming visits in private pools or what the costs may have been with any public locations. Moreover, we were also unable to compare either type of outdoor swimming visit with indoor swimming trips to see whether there are any additional benefits of being outdoors. We also know relatively little about open-water locations, although the fact that perceived water quality was positively associated with positive-wellbeing and negatively associated with negative well-being highlights the importance of quality across both settings. Since swimming visits were only a small part of the survey we were unable to ask for more details here.

Sixth, although we framed the research in terms of self-determination theory (SDT), we recognise that other theoretical approaches may offer additional insights that were not explored with the current variables. For instance, from an attention restoration theory (ART, Kaplan & Kaplan, 1989) perspective we might hypothesise that outdoor swimming benefits subjective well-being through a recovery of attentional and other cognitive resources; from a stress recovery theory (SRT, Ulrich, 1983) perspective we might attribute possible benefits to a reduction in negative physiological and emotional states; and from a nature-based biopsychosocial resilience theory (NBRT; White et al., 2023) perspective, we might propose that outdoor swimming builds a range of biological, psychological and social resilience resources that ultimately promote broader well-being. We also recognise broader conceptual models of how contact with blue spaces more generally may benefit health and well-being such as the salutogenic approach (Völker & Kistemann, 2011) which recognises blue spaces as not just 'activity spaces' (e.g. places to swim), or 'social spaces' (e.g. places to connect to others), but also 'experienced spaces' and 'symbolic spaces' which would require greater consideration of issues such as place attachment and connection to the natural world, especially with respect to the wild swimming, than we were able to explore here. This is where the relatively substantial body of qualitative studies (e.g. Evers & Phoenix, 2022; Foley, 2015; Olive & Wheaton, 2021) plays an important role (Ratcliffe et al., 2023), and we see the current work as being complementary to those efforts by highlighting the generalisability of the positive benefits of open-water swimming. Future work is needed to explore how these different theoretical and methodological approaches could be integrated to provide a more holistic understanding of the benefits of outdoor swimming.

Finally, our data was cross-sectional and as we only explored a single visit we were unable to explore causality or patterns of potential benefits over time (Foley, 2017). Our exploration of potential mediating mechanisms thus has to be viewed with caution. Moreover, visits were entirely self-selected (and presumably voluntary), therefore we also recognise that swimming outdoors in any setting, especially for non- or low confident swimmers, may not be a positive experience or satisfy intrinsic needs in all cases. Thus, we see our findings as complementary to more intervention-based and longitudinal research (Burlingham et al., 2022; Massey et al., 2020).

### 4.3. Implications and conclusions

Although we focused primarily on comparing two forms of outdoor swimming, in order to tease out the additional effect of swimming in "wild" locations, one of the most striking findings was the overall high levels of positive affect (and low levels of anxiety) associated with swimming in either location. Importantly, these positive effects were consistent across both coastal and inland open-water swimming locations. The potential implications are that promoting and supporting outdoor swimming generally may be a good way of building individual, and possibly community, levels of well-being.

As noted above, due to natural variability in availability, efforts to support the development and maintenance of open-air pools may therefore be particularly important for inland countries (e.g. Austria, Czech Republic) and cities (e.g. Berlin). Nonetheless, given the clear importance of perceived and objective water quality, public and private (where appropriate) investment to maintain bathing water standards needs to be made and maintained in all jurisdictions (Leonard et al., 2018). People appear highly sensitive to information regarding water quality levels and will travel further to swim in less polluted waters (Börger et al., 2021). Our findings thus add support to efforts to keep natural bathing waters as clean and healthy as possible, not just to reduce cases of illness but also to promote positive mental health outcomes. That these spaces may be visited particularly often for swimming by those in the lowest income households, is also suggestive of potential income-related health inequality reducing opportunities for these crucial blue space locations.

Beyond these well-being benefits, our findings suggest that individuals with limiting illnesses or disabilities reported higher levels of competence while swimming. This aligns with qualitative research highlighting that open-water swimming can provide relief and increased mobility for individuals with chronic conditions such as arthritis (e.g. Lindqvist & Gard, 2013; Song & Oh, 2022). The properties of water facilitate movement and potentially allow these individuals to feel more physically capable compared to being on land. Additionally, exposure to cold water has been associated with pain relief after exercise (e.g. Bleakley et al., 2012) and with lower levels of depression, anxiety, and stress (Mullooly & Colbert, 2024), as well as time-dependent effects on inflammation, stress, immune function, sleep quality, and quality of life (Cain et al., 2025). Given that swimming can offer significant benefits for individuals with chronic conditions, ensuring that outdoor swimming spaces are accessible and of high quality could have considerable public health implications for a wide range of individuals.

Safety is also likely to be critical, with respondents tending to still visit open-air pools more with children. This suggests greater lifeguarding infrastructure etc. may also be an important investment, if we are to encourage greater use of "wild" swimming locations, especially among those seeking to strengthen their children's psychological bonds with blue spaces, bonds that can benefit their psychological well-being over their entire life-course (Vitale et al., 2022).

Finally, while acknowledging the cross-sectional limits of the data, results suggest that the primary mechanism through which open-water (vs. open-air pool) swimming may promote subjective well-being is through the greater satisfaction of autonomous motives and enhanced feeling of being true to oneself. Perhaps, in a world of growing externally motivating drivers and pressures, this is a key reason why wild swimming is becoming increasingly popular.

## CRediT authorship contribution statement

**Wencke Groeneveld:** Writing – review & editing, Formal analysis, Data curation. **Morris Krainz:** Writing – review & editing, Formal

analysis, Data curation. **Mathew P. White:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Anja Heske:** Writing – review & editing, Writing – original draft. **Lewis R. Elliott:** Writing – review & editing, Methodology, Data curation. **Gregory N. Bratman:** Writing – review & editing, Funding acquisition. **Lora E. Fleming:** Writing – review & editing, Funding acquisition. **James Grellier:** Writing – review & editing, Methodology. **Craig W. McDougall:** Writing – review & editing. **Mark Nieuwenhuijsen:** Writing – review & editing, Funding acquisition. **Ann Ojala:** Writing – review & editing, Funding acquisition. **Sabine Pahl:** Writing – review & editing, Funding acquisition. **Anne Roiko:** Writing – review & editing, Funding acquisition. **Matilda van den Bosch:** Writing – review & editing, Funding acquisition. **Benedict W. Wheeler:** Writing – review & editing, Funding acquisition.

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## Declaration of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2025.102558.

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